

Aristoxenus of Tarentum and The Birth of Musicology

Sophie Gibson

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Series Editors' Foreword

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Dirk Obbink, Oxford University
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Preface

This book was originally written as a D. Phil. thesis submitted to the Faculty of Literae Humaniores at Oxford University in 2002. Many people have contributed to it, and I am very grateful to them for their help. My greatest debt is to my supervisor, Dr Martin West of All Souls College, who corrected my many errors and discreetly but firmly guided my research and thinking throughout the degree. At his door much of the academic merit of this work is to be laid. Dr Matthew Leigh, my advisor at St Anne's College, has been a source of great encouragement and assistance since I arrived in the United Kingdom in 1998. Professor Robert Wallace of Northwestern University very kindly read and made detailed comments on a couple of the early chapters. The thesis examiners, Professor Dirk Obbink of Christ Church College, Oxford, and Professor Andrew Barker of the University of Birmingham, were careful and thorough in their assessment of the thesis and made many constructive recommendations for its revision. Professor Barker was also very generous with additional advice and encouragement while I was preparing the thesis for publication. He has been particularly kind in reading again the final chapter and making many suggestions for its further improvement.

Margaret and John Balla lent their enthusiastic financial and personal support throughout a degree which I would otherwise have been unable to undertake. Finally, Dr Adrian Kelly was reassuring and patient while I researched, wrote and revised the thesis, and diligently read my work more times than spousal duty actually demanded.

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Introduction

That music was an important part of Greek life is undeniable. There is ample evidence, both literary and archaeological, which has come through to us from antiquity demonstrating the pervasiveness of practical music making. Similarly, there survives considerable philosophical discussion by the Greeks about what music meant to them, relating not only to the definition of its ideal role in society but also to the definition of music's essential elements and how they are organised.¹ The theoretical discussion of music naturally occurred in the context of other Greek philosophical enquiry and was influenced by it.

Aristoxenus of Tarentum took part in this discussion on all levels, but most importantly in the context of music theory. His contribution was to turn musical science—almost single-handedly—from an exploration of the relationships of numbers into an investigation of the way in which sound could be arranged and understood as music. His vindictive nature was infamous, yet his musical knowledge was so extensive and his authority on the subject so unchallenged in antiquity that he earned the title ὁ Μουσικός.² This reputation was justly founded both on the breadth of his musical research and on the depth of his investigations into harmonics and other specific areas.

The major evidence for Aristoxenus as a philosopher and musician is obviously his *Harmonics*. The treatise itself, as well as its permutations and influence in later antiquity, establishes his dominance in this field. Nevertheless there are other sources which, while confirming some elements of his harmonic methodology, demonstrate aspects of the author's scholarship and intellectual interests which are not evident in that treatise. In addition to the theoretical side of musicology, Aristoxenus' general musical competence is seen in the evidence for an extensive range of writings—only surviving in fragments—in other musical areas: organology, dance, melody, tragedy, education and history. From these fragments we can see that his main extant work, the *Harmonics*, does not give the full picture of his approach to the subject of music.

Considerable evidence also exists for his works on other subjects, such as biography, education, law, and in particular, Aristoxenus' extensive writings on the Pythagoreans and Pythagoreanism. Nevertheless, despite his broader philosophical interests, he is comparatively rarely cited in contexts completely independent from music, and by several authors he is mentioned as the typical example of a musician. Indeed, his reputation rests almost entirely upon his musical writings and he is cited most often from these works.

The aim of this work is to establish the contribution of Aristoxenus of Tarentum to the development of musicology. Arguably, Aristoxenus can be seen as the founder of this science and as the person who established music theory as an independent subject. The full range of evidence indicating the extent to which this proposition can be supported has not yet been collected and examined in a single study. The *Harmonics* itself has been much discussed, and the *Rhythmics* less so, but some of the other evidence of Aristoxenus' musical scholarship has been largely sidelined. Undeniably, Aristoxenus' principal contribution to the subject is theoretical innovation, but he was a general authority on music throughout antiquity and the connections between his writings on harmonics and his other musical works show that he conceived the different parts of musical investigation as an interdependent whole.

In claiming Aristoxenus as the founder of musicology, the nature of that science must be defined. Modern musicology incorporates many variously related elements, including theory, acoustics, organology, harmony, rhythm, aesthetics, and history amongst others.³ One important aspect of the science treats the way in which music is structured and given order; that is, the reason why a particular collection of sounds appears to the listener as music and not merely a cry from the primitive void. For the ancients these concerns also formed part of musical investigation, and there was certainly a great deal of discussion about different areas within the field before Aristoxenus stepped onto the scene. However, these discussions show little ambition to discuss music in a systematic and scientific way, independently from considerations of mathematical coherence or educational and ethical value. This was Aristoxenus' achievement.

The intellectual environment in which Aristoxenus developed his methodology for musical investigation is perhaps an appropriate place to start in order to get an idea of the significance of his writings. However, little is known about his life, and the account of the *Suda*—the most substantial biography we have—is limited to say the least. Born around 360 BCE, Aristoxenus' early life appears to have been spent in the surrounds of Pythagoreanism.

Ἀριστόξενος υἱὸς Μνησίου, τοῦ καὶ Σπινθάρου, μουσικοῦ, ἀπὸ Τάραντος τῆς Ἰταλίας· διατρίψας δ' ἐν Μαντινεΐα φιλόσοφος γέγονε, καὶ μουσικῇ ἐπιθέμενος οὐκ ἡστόχησεν, ἀκουστῆς τοῦ τε πατρὸς καὶ Λάμπρου τοῦ Ἐρυθραίου· εἶτα Ξενοφίλου τοῦ Πυθαγορείου, καὶ τέλος Ἀριστοτέλους· εἰς ὃν ἀποθανόντα ὕβρισε, διότι κατέλιπε τῆς σχολῆς διάδοχον Θεόφραστον, αὐτοῦ δόξαν μεγάλην ἐν τοῖς ἀκροαταῖς τοῦ Ἀριστοτέλους ἔχοντος. Γέγονε δ' ἐπὶ τῶν Ἀλεξάνδρου καὶ τῶν μετέπειτα χρόνων· ὥς εἶναι ἀπὸ τῆς ριά Ὀλυμπιάδος, σύγχρονος Δικαιάρχῳ τῷ Μεσσηνίῳ· συνετάξατο δὲ μουσικά τε καὶ φιλόσοφα, καὶ ἱστορίας, καὶ παντὸς εἶδους παιδείας, καὶ ἀριθμοῦ αὐτοῦ τὰ βιβλία εἰς νηγ'.⁴

Aristoxenus son of Mnesias, or Spintharos,⁵ was a musician, from Tarentum in Italy. Having spent time in Mantinea he became a philosopher, and he did not fail to apply himself to music. He was a student of his father and of Lampros of Erythrae, then of Xenophilos the Pythagorean, and finally of Aristotle. The latter he insulted after his death, because he left Theophrastus as successor of the school, even though he (Aristoxenus) had great reputation among the students of Aristotle. He lived in the time of Alexander and afterwards: that is from the 111th Olympiad, contemporaneously with Dicaearchus of Messina; he composed on music and philosophy, and history, and education of all types, and his books number 453.

This extract gives us only a vague outline of Aristoxenus' life and it is not only brief, it is late and unreliable. Nevertheless, we can at least glean from it various philosophical influences which clearly contributed to Aristoxenus' intellectual background. Firstly, the musical training from his father Spintharos would have started at an early age and it continued in Mantinea where musical traditions were strictly maintained by the state.⁶ The second important influence on Aristoxenus' development was Pythagoreanism. Born in Tarentum, the town in which both Archytas and Philolaus had lived, it can be seen that the extended period of time that Aristoxenus spent in a Pythagorean environment made an indelible impact on the subject matter of his writings. Such titles as Πυθαγόρου βίος, Περὶ Πυθαγόρου καὶ τῶν γνωρίμων αὐτοῦ and Περὶ τοῦ Πυθαγορικοῦ βίου indicate Aristoxenus' interest in the society. Furthermore, his works on education show evidence of Pythagorean influence, particularly in their tendency towards conservatism. Most importantly, speculation on the structure of music had its origin in a Pythagorean environment. Its focus was on the numerical relationship between notes and, at its furthest stretch, developed into a comparison between

musical, mathematical, and cosmological structures. Aristoxenus eventually rejected this mathematical approach to the study of music and attempted to establish an empirical science of harmonics.

This empirical emphasis may have been owing to the third major influence on Aristoxenus mentioned in the Suda passage: Aristotle. The Suda documents Aristoxenus' egoism and petulance, that he slandered his teacher when Theophrastus was the favoured successor.

Despite the variety of areas listed in the Suda entry in which Aristoxenus wrote—music, philosophy, history and education—it is his work on music and specifically the *Harmonics* which is the primary focus of this study. It is probably not by chance that this is the Aristoxenian work which has most completely come down to us. It is in the *Harmonics* that the importance of Aristotle's philosophical influence on Aristoxenus is most clearly demonstrated. Through this work, Aristoxenus creates new imperatives for the investigation of harmonics and takes very much to heart doctrines inherited from Aristotle about the nature of science. Although he differs from his teacher by rejecting a type of musical analysis which is based on numerical relationships in favour of an empirical exposition, his work demonstrates many of Aristotle's general precepts about science discussed in the *Posterior Analytics* and elsewhere.

In addition to his musical training and the influence of the Pythagoreans and Aristotle, there is a fourth element which shaped Aristoxenus' harmonic theory. There were theorists active in Athens in the fourth century, not of the Pythagorean school, who could be considered as the precursors to Aristoxenus in their experiential view of musical structures. Aristoxenus heavily criticises their attempts at describing musical systems, yet uses their work as a stepping-stone to developing his own theories. Like them, he seeks to describe the structures of melody in ways corresponding to the manner in which they are represented to human perception. However, an empirical description of music was not the limit of Aristoxenus' ambition: he seeks to establish an autonomous science.

The *Harmonics* demonstrates Aristoxenus' ability to create an independent science for the field of harmonics, developing (but more often rejecting) earlier musical methodologies, and applying Aristotelian scientific doctrine to the subject. Musicology as it is presented by Aristoxenus is therefore the culmination of several centuries of musical speculation, but he is nevertheless justified in proclaiming his innovative role in the development of the discipline. He brings together for the first time all the elements of earlier musical scholarship, examines, judges and organises them, discards that which he sees as irrelevant, and establishes a method for the comprehensive analysis of the various parts of the subject as a whole.

The resulting work, in three books, describes firstly the object of harmonic science which is the study of melody. It lists the parts which make up melody—note, interval, and scale—and discusses the prescribed patterns which form the framework of melodic composition. Unfortunately the work survives incomplete and we do not have the sections which Aristoxenus clearly anticipated concerning the larger scale systems and the relationships between different modes and keys. This would have been invaluable for our understanding of Greek musical theory.

An important aspect of Aristoxenus' concept of harmonic science is its separation from other disciplines. This is not only in relation to extra-musical study but also the other areas within the larger sphere of a musician's necessary accomplishments. Throughout his writings on music Aristoxenus makes a point of dividing musical knowledge into distinct subjects, each of which involves different aspects to be examined and understood, and which, although interrelated and often overlapping, are to be discussed with appropriate criteria and language. This methodical approach appears to have evolved over a period of time and it is only in the context of Aristoxenus' writings as a whole, as far as we know them, that we can see the gradual development of his methodology and the way in which it unified his musical philosophy.

Outside the *Harmonics*, Aristoxenus' musical writings include a range of subjects and styles. The extended fragment from the *Rhythmics*, and the material of other authors dependent on it, shows how Aristoxenus approached a similarly technical aspect of the field. Furthermore, the author of the Ps.-Plutarchean *De Musica* (1st or 2nd century CE), in his extensive citations from Aristoxenus, evidences a broader range of subject matter and a flexibility of scholarly technique in the writings of the musician. This is supported by Aristoxenian citations in Athenaeus' *Deipnosophistae* although they comprise a far smaller proportion of that work. In addition to these there are the shorter fragmentary references to Aristoxenus, collected by Wehrli, which give further information on his philosophical methodology, his writings, life, and how he was perceived by the ancient writers. These confirm Aristoxenus' wide-ranging approach to music and his application of complementary methodologies to different areas of the field.

Despite the broad range of topics treated by Aristoxenus, only the *Harmonics* stands out as a major contribution to the development of the science of musicology. His innovations in this subject are easily apparent while evidence for an equivalent advance in other areas is less readily available. Consequently, it is necessary to examine the aspects of Aristoxenus' work in the *Harmonics* which may have ensured its general acceptance and continuing influence while his other work seems to have fallen by the wayside. Perhaps

Aristoxenus' blend and development of Aristotelian and Pythagorean ideas is particularly suited to this subject, enabling him to take music theory to a higher level, and ensuring his eminent position as a musical authority throughout antiquity and, through Boethius, into the Middle Ages.

The impact which Aristoxenus has made on the study of music is the central focus of our interest in him. Of particular concern is the way in which he has adopted earlier philosophical and literary methods from a range of sources while establishing an independent approach to his chosen field. Before Aristoxenus there were, of course, some treatises which included musical aspects, others which principally concerned music but, owing particularly to Pythagorean adherence in these works, the concern was less about music itself than about its position in a mathematically coherent universe. The work of the theorists whom Aristoxenus calls *harmonikoi* constituted only the most rudimentary beginnings of an alternative approach to musical science. Musicology cannot really be said to have been born until Aristoxenus' harmonic treatise took it out of a cosmological context and examined it independently and systematically.

Harmonic Theory Before Aristoxenus

INTRODUCTION

Aristoxenus' *Harmonics* embodies both the culmination of several centuries of discussion about the nature of musical sound as well as the establishment of an entirely new method of treating that subject. Furthermore, his innovative conception of the subject as it appears in the *Harmonics* is not merely a tentative exploration of the possible status of a newly independent science, but appears in his treatise in an advanced stage of development. That is not to say that, even from what is left to us, we cannot see oversights in aspects of its realisation, and its internal structure indicates that it did not spring fully formed from its author's head. Since the sixth-century Pythagorean speculations, and the first book about music written by Lasus of Hermione,¹ there had been continuous discussion on the subject, within and without the Pythagorean school. In the fourth century music was one of the subjects worthy of serious scientific inquiry for Plato and Aristotle.² Despite these precursors, as a treatise which aims at a coherent description and explanation of musical structures as an independent science capable of axiomatic exposition, the *Harmonics* of Aristoxenus has no comparable predecessors; considering this, it is a surprisingly sophisticated work.

Aristoxenus relies on the explorations of earlier theorists to define the boundaries and methodology of the subject. While much of the structure of his discussion is modelled on Aristotelian principles and is even in some respects derived from Platonic expository methods, a large part of the content of the introductory passages in Books I and II shows Aristoxenus' reaction against the work of previous scholars in the field. This is evident in the way in which he combines criticism of his predecessors with his statements of purpose. Even as he condemns the transgressions of the empirical *harmonikoi* and Pythagorean mathematical theorists, he refines his own concept of the science of harmonics. Yet his rejection of arithmetically-based theories demands that he provide another frame of reference for the organisation of musical space.

In the first book (which I believe to be an early draft of the second), Aristoxenus is still not entirely clear about how he can give coherence to his theory without allowing himself recourse to arithmetic. Some hint of how this will be realised is apparent in such ideas as *συνεχές*, *ἐξῆς* or *ἐφεξῆς* (continuity, sequence and succession) expressing a notion of continuity within an interdependent system, but this is still an undeveloped and unsatisfactory concept. In the second book the necessary structure is achieved with the refinement of this concept through that of *dynamis*.³ Thus we can see the progressive construction of Aristoxenus' treatise. Firstly, the desire to raise harmonics to the level of an independent science necessitates the rejection of dependence on mathematical expression, and effectively negates most of the results of Pythagorean musicological inquiry. Secondly, Aristoxenus provides, as Aristotle does in many cases, an overview and analysis of previous scholarship in the opening sections of the work, generally omitting reference to the mathematicians, but containing considerable criticism directed against other groups who did not come up to his high standard. From here a first draft is built around the inadequacies of earlier empirical theories and the ambition to make sense of musical space without referring to a mathematical structure, then a second draft is produced, whose theoretical construction is now reinforced by the concept of *dynamis* and by a broader and clearer perspective of the contribution its innovations play in the development and perfection of musicological scholarship. The third book is an attempt at an axiomatic expression of the science, employing the concept of *dynamis* developed in Book II.

Aristoxenus' dismissal of Pythagorean thought in this field is not a rejection of their school per se, but an attempt to construct a framework for harmonics outside mathematics and thereby create an independent science. On the other hand, the criticism he throws against empirical theorists gives him a starting point for his own approach. He is quick to condemn their mistakes (as he perceives them) and to develop his methodology in opposition. The reactive nature of his theory is particularly apparent in the introductory sections of Books I and II. With reference to that material, we shall examine in this chapter the predecessors of Aristoxenus and the way in which he uses their explorations in the subject of harmonics to establish his own definition of the subject.

1. PYTHAGOREANISM

1a. Music and Cosmology in Pythagorean Thought

Early Greek musical theory is based around the fact that numerical ratios can be used to express musical intervals, and that certain simple ratios 2:1, 3:2 and 4:3 represent the fundamental consonant intervals of octave, fifth and

fourth.⁴ The theory became quickly concerned—among other things—with the intervals smaller than a fourth and with the ratios that would best express them in this mathematically irregular system.

The Pythagorean approach to musicology has been extensively examined elsewhere⁵ and here a summary treatment will suffice, focusing mainly on elements which have a bearing on Aristoxenian thought. Aristoxenus himself is one of our principal sources for evidence on the Pythagoreans and their way of life and he shows great respect for their discipline.⁶ Although no writings of Pythagoras himself survive, and evidence for the beliefs of any particular member of the Pythagorean school before Aristoxenus is limited, some essential points can be established about their concerns in relation to the study of music. Most importantly it must be noted that Pythagorean musical speculation, at least before Archytas, was carried out within a general programme of investigating the structure and organisation of the cosmos and its mathematical foundations.⁷

A passage from Aristotle's *Metaphysics* provides the earliest and most reliable general summation of Pythagorean musical theory. Although he does not differentiate much between different thinkers or chronological development in the school, Aristotle does highlight the numerical and cosmological emphasis of their musical studies: ἐτι δὲ τῶν ἀρμονιῶν ἐν ἀριθμοῖς ὁρῶντες τὰ πάθη καὶ τοὺς λόγους,—ἐπεὶ δὴ τὰ μὲν ἄλλα τοῖς ἀριθμοῖς ἐφαίνοντο τὴν φύσιν ἀφωμοιωθῆαι πᾶσαν, οἱ δ' ἀριθμοὶ πάσης τῆς φύσεως πρῶτοι, τὰ τῶν ἀριθμῶν στοιχεῖα τῶν ὄντων στοιχεῖα πάντων ὑπέλαβον εἶναι, καὶ τὸν ὅλον οὐρανὸν ἀρμονίαν εἶναι καὶ ἀριθμόν.⁸ Some twenty lines later, Aristotle attributes the idea of cosmic harmony specifically to the Pythagoreans without any negative judgement, but elsewhere, in the *De Caelo*, he argues against its possibility. φανερόν δ' ἐκ τούτων ὅτι καὶ τὸ φάναι γίνεσθαι φερομένων (sc. τῶν ἀστρον) ἀρμονίαν, ὡς συμφῶνων γινομένων τῶν ψόφων, κομψῶς μὲν εἴρηται καὶ περιττῶς ὑπὸ τῶν εἰπόντων, οὐ μὴν οὕτως ἔχει τὰληθές.⁹ With considerably more brevity, Plato also mentions the connection of astronomy and harmonics in Pythagorean thought: κινδυνεύει, ἔφη, ὡς πρὸς ἀστρονομίαν ὅμματα πέπηγεν, ὡς πρὸς ἐναρμόνιον φορὰν ὦτα παγῆναι, καὶ αὗται ἀλλήλων ἀδελφαί τινες αἱ ἐπιστῆμαι εἶναι, ὡς οἱ τε Πυθαγόρειοί φασι καὶ ἡμεῖς, ὦ Γλαῦκων, συγχωροῦμεν.¹⁰ The Pythagoreans were a religious brotherhood and musical investigation was merely one part of a broader agenda.¹¹

Two fundamental elements of Pythagorean concern clarify their focus in the area of harmonics. The first is the dualism conceived in the construction of the universe, as expressed in the ten pairs of opposites headed by 'Limit and

Unlimited' listed by Aristotle in the *Metaphysics*.¹² The second element is an equation of things (corporeal or not) with numbers.¹³ Both ideas highlight a philosophy which reflects the lack of differentiation between the concrete and the abstract in pre-Socratic thought, and contribute to a number-based account of the universe. These concerns, along with the connection of low-integer ratios to some consonant intervals, led the Pythagorean theorists to establish their harmonic theory on arithmetical relationships and to raise to a cosmological level the significance of consonant musical intervals.

The contrast of Limit and Unlimited, Odd and Even happily fits the musical analogy on several levels. The numbers 1, 2, 3 and 4, which define the consonances, not only construct the all-important decad¹⁴ but, in the same way as Limit acts on the Unlimited to give form to the cosmos, these numbers also define, divide and limit the unlimited realm of musical space into a more comprehensible structure. Further, as epimoric ratios must by definition include an odd and an even number,¹⁵ the two smallest consonant intervals of fourth and fifth confirm the importance of this duality of odd and even.¹⁶

Beyond these general items of information, evidence for actual musical theory within the Pythagorean school is scanty. Pythagoras himself, in some sources, is credited with the discovery of the ratios of the consonances of fourth, fifth and octave.¹⁷ The story relates that Pythagoras was walking past a smithy and noticed that the hammers striking the metal on the anvil sounded in consonance, and on investigation found that they had weights differing according to certain numerical ratios. The acoustic impossibility of this event shows it to be spurious and relegates it to the status of popular mythology. Furthermore, the practical application of these measurements may already in the sixth century have been recognised by makers of musical instruments;¹⁸ alternatively, it is possible that Pythagoras had encountered such calculations outside Greece.¹⁹ On the other hand, it is feasible that Pythagoras did reveal these relationships discovered independently from any smithy incident, and in any case, there is sufficient evidence that in the early Pythagorean school experiments were carried out to confirm these relationships. There are references to the harmonic experiments involving vases filled with different amounts of water conducted by Lasus of Hermione,²⁰ and to those of Hippasus of Metapontum carried out on disks of different thickness, on which Glaucus of Rhegium is praised for his skill in making music.²¹ The identification of the precise author of the discovery bears less significance than its early appearance in the sect's musical thinking.

On a more theoretical level, Philolaus, in the late fifth century, enumerated the names and ratios of the basic concords and the ratio for the whole

tone.²² The relevant passage, as quoted by Stobaeus, emphasises the cosmic correlation to music but also demonstrates Philolaus' understanding of measurements for the diatonic tetrachordal division of 256:243 9:8 9:8.²³ The precise 256:243 ratio may not have been established by Philolaus himself but it is clear that he is aware that this interval is not an exact semitone because he defines the octave as five 9:8 tones plus two *dieses* rather than as six tones.²⁴ In any case, this division of the fourth was known by the time of Plato, who used it in the *Timaeus* (36a-b). Philolaus' application of the mathematical tools of music is further attested in his discussion of musical proportion.²⁵

A later Pythagorean, Archytas of Tarentum (active in the first half of the fourth century),²⁶ was concerned not only with mathematical arrangement of musical space but also with physical properties of sound.²⁷ He continued Philolaus' discussion on musical proportion, defined the three means of music (arithmetic, geometric and harmonic or subcontrary),²⁸ and applied both the harmonic and the arithmetic mean in his tetrachordal calculations for each of the genera. Most importantly, Archytas established the proof that epimoric intervals could not be divided into equal parts—a point which epitomises the difference between Pythagorean and Aristoxenian methods.²⁹ Furthermore, he admits the debt he owes to calculations of earlier Pythagoreans, whose musical speculation he lists alongside their studies in astronomy and other sciences; he may perhaps be hinting at a continuing connection between these disciplines in Pythagorean thought: *περί τε δὴ τῶν ἄστρον ταχυτάτος καὶ ἐπιτολάν καὶ δυσίων παρέδωκαν ἅμιν διάγνωσιν καὶ περὶ γαμετρίας καὶ ἀριθμῶν καὶ οὐχ ἥκιστα περὶ μουσικῆς. ταῦτα γὰρ τὰ μαθήματα δοκοῦντι ἡμεν ἀδελφεά.*³⁰

In the light of this evidence it is clear that, for the Pythagoreans, a mathematical fascination connected harmonics to cosmology. This stemmed from the cultic environment in which scientists and philosophers of the Pythagorean school sought enlightenment from contemplation of the universe. Therefore it is not surprising that their concept of harmonics focuses on abstract and arithmetical aspects of music. But of course, music was a pervasive element in Greek life, and so we must now consider the relation of their calculations to musical practice.

1b. Pythagoreanism and its Relation to Practical Music

Plato criticises the Pythagoreans for not taking harmonic number theory beyond the practical experience of music: *ταῦτόν γὰρ ποιοῦσι τοῖς ἐν τῇ ἀστρονομίᾳ· τοὺς γὰρ ἐν ταύταις ταῖς συμφωνίαις ταῖς ἀκουόμεναις ἀριθμοὺς ζητοῦσιν, ἀλλ' οὐκ εἰς προβλήματα ἀνίστανται, ἐπισκοπεῖν τίνες ξύμφωνοι ἀριθμοὶ καὶ τίνες οὐ, καὶ διὰ τί ἑκάτεροι*

... χρήσιμον μὲν οὖν . . . πρὸς τὴν τοῦ καλοῦ τε καὶ ἀγαθοῦ ζήτησιν, ἄλλως δὲ μεταδιωκόμενον ἄχρηστον.³¹ For Plato, the study of harmonics should lead to some understanding of the abstract “good,” for otherwise it is useless. He seems to conceive a harmony inherent in the very nature of number which then could be the basis for some abstract, formal and universal theory independent from musicology. In his description in the *Timaeus*, Plato constructs the soul of the world from the numbers involved in harmonic speculation and from the means described by Archytas, and omits any actual mention of music.³² In contrast, Pythagorean musical ambition up until Plato’s time sought the ratios of harmonic structures reflected in a universal pattern of nature, but did not omit reference to the framework of music itself. Where Plato seeks an abstract numerical pattern of which the sublunary numerical structure is a pale reflection, the Pythagoreans seek to map the order within the actual physical universe.

The empiricism inherent in the connection of numerical ratios to audible consonances of fourth, fifth and octave is inevitably where musical-mathematical discussion begins, and the Pythagorean discourse is no exception. Despite developing its numerical framework, the Pythagorean method of dividing the tetrachord into three intervals does not reflect an attempt to escape reference to the practical sphere. It is all too easy, in the context of the emphasis placed on the reason-perception dichotomy later applied to Pythagorean-Aristoxenian schools of harmonics, to forget the practical origin and early development of Pythagorean investigation of the subject. The ratio series put forward by the Pythagorean school are often accurate mathematical representations of the scales and techniques of practising musicians. For example, a tuning such as Philolaus’ diatonic (256:243 9:8 9:8), adopted by many authors, mirrors the traditional method of players of stringed instruments who tune by consonances to obtain tone intervals, up a fourth and down a fifth (or vice versa).³³ There is no need to question these conclusions on the grounds that the abstract calculations attributed to Philolaus by Boethius can have no relevance to musical practice, since there are overwhelming reasons for considering them spurious.³⁴

Pythagorean theory developed from the time of Philolaus to entrench epimoric ratios in mathematical theory. The initial division between consonant and dissonant intervals is defined by the use of ratios only containing the numbers one to four. A further distinction locates any further epimoric intervals on a sliding scale from more to less consonant. The smaller the numbers in the epimoric ratio, the more consonant it is. The connection of consonant intervals to such ratios then gives a framework for determining the admissibility to melody of intervals smaller than the smallest consonance, specifically

the intervals which divide the tetrachord. However, even a superficial examination reveals that superparticular ratios for intervals are less of a concern to the early Pythagoreans than the later. We can see in the historical development of tetrachordal divisions from Philolaus to Archytas, and over the centuries to Ptolemy, how the exclusion of non-epimoric ratios for individual intervals became an imperative for Pythagorean theorists. Ptolemy's own criticism of Archytas' divisions indicates the conscious refinement and application of mathematical techniques in this field.³⁵

Indeed, Ptolemy says of Archytas that *μάλιστα τῶν Πυθαγορείων ἐπιμεληθεὶς μουσικῆς πειράται μὲν τὸ κατὰ τὸν λόγον ἀκόλουθον διασῶζειν, οὐκ ἐν ταῖς συμφωνίαις μόνον, ἀλλὰ καὶ ταῖς τῶν τετραχόρδων διαιρέσεσιν, ὡς οἰκείου τῇ φύσει τῶν ἐμμελῶν ὄντος τοῦ συμμετρου τῶν ὑπεροχῶν*.³⁶ He attributes to him the achievement of distinguishing the three genera and providing calculations for the ratios of each, but criticises the results as not sufficiently according to reason, *κατὰ τὸν λόγον*, as well as *ἀπᾶδων δὲ σαφῶς τῶν ἄντικρυς ἤδη ταῖς αἰσθήσεσιν ὠμολογημένων*.³⁷ Indeed, in the work of Archytas the balance between reason (an emphasis on certain types of numerical ratios) and perception (a representation of musical reality) gives no clear preference to the former. However, within a framework of representing musical data Archytas has made ample room for rigorous mathematical precepts. The criticism that Archytas is "patently out of tune with the senses" is refuted by the similarity of the tetrachordal divisions described by Archytas and by Aristoxenus.³⁸ Despite their different methods of expression, this similarity indicates the realisation of a common desire to represent with some accuracy the actual intervals used by musicians. Archytas' inclusion of the 5:4 (387 cents) major third in the enharmonic genus not only makes use of an epimoric interval, it most likely represents the interval in use by musicians who could have obtained it by tuning a ditone by consonances and then adjusting the interval to the major third for greater sweetness. This seems to be a mathematical representation of the practice to which Aristoxenus disparagingly refers in the *Harmonics*.³⁹ On the other hand, the interval of 28:27, unchanged in all three of Archytas' genera, has a doubtful association with musical practice. It is possible that it reflects a rising interval of five *dieses* called the *ekbole*, mentioned by Ps.-Plutarch (most probably citing Aristoxenus) and defined by Aristides Quintilianus and Bacchius Geron.⁴⁰ In any case, it does not reflect any other surviving representation of the genera, which all posit two moveable notes within the tetrachord.

With regard to mathematical success and consistency, although Archytas' tetrachordal divisions contain some unexpected ratios, Barker has

established that they are an interdependent set and their ratios can all be obtained from epimoric intervals of numbers smaller than ten.⁴¹ Even in the chromatic division 28:27 243:224 32:27, the apparently arbitrary and awkward intervals can be achieved by simple combinations of low integer epimoric ratios. Ptolemy's criticism of Archytas' lack of reason may be evidence that the criterion for the melodic tetrachord narrowed from one based on the system as a whole, one which gains coherence from intervallic relationships even between genera, to one based on individual intervals. Alternatively, the later theorist may not have registered this semi-cryptic structure, for his own interval divisions use only epimoric intervals, with the one exception of the ditonic diatonic which includes the accepted *leimma* of 256:243 after two 9:8 tones.

Therefore, Plato's criticism that the Pythagoreans did not abstract universal principles from phenomena apparent in musical practice appears to be broadly acceptable, though it seems applicable to Archytas only with some qualifications. Despite its vague ambition to obtain a mathematical system over which to map musical structures as well as cosmological ones, Pythagorean harmonic investigation appears to have had constant recourse to musical practice.

However, the difference between Pythagorean and Aristoxenian methods as they are described by later commentators is not entirely clear, and becomes more clouded later on, through the cross-contamination of their techniques. That mathematical calculations appear to have been emphasised at the expense of depicting musical phenomena is a commonly expressed distinction between the two approaches. Indeed, it is easy for the commentator to become absorbed in this apparent striving for a symmetrical number system and, in the light of Aristoxenus' empirical dogmatism, to overlook the relationship between Pythagorean theory and practical music. However, numerical associations in the Pythagorean system are not for the sake of mathematical symmetry alone. They reflect a concern to map a cosmological order and it is this emphasis which directs their studies. It is not that Aristoxenus does not have any mathematical framework, or that he is not guilty of manipulating his discussion for the sake of some conceptual symmetry. Nor is it the case that the early Pythagoreans ignore the realities of musical practice in order to create an intellectually satisfying and numerically accurate structure. It is rather that Aristoxenus does not seek to impose a cosmological, universal or even arithmetical framework on his musical structure, nor to rationalise audible consonances with a physical-acoustical account; instead he wishes to define a complete musical science independent from the demands of other sciences. This limits his success on a mathematical level but, owing to the

theoretical structure accorded by the concept of *dynamis*, does not restrict the potential of his general thesis.

1c. Aristoxenus' Rejection of Pythagoreanism

The Pythagorean method for explaining musical structures could not have been unknown to Aristoxenus. The combination of Pythagorean instruction before he joined the Lyceum, and the fact that his father was a musician, cannot have left him ignorant of their musical speculation and interval ratio calculations. Even if these things had, by some strange twist, originally escaped his notice, there is evidence that Aristotle himself had some familiarity with these ratio calculations and would surely have passed on the information.⁴² Furthermore, as there are some oblique references in the *Harmonics* to ratios and mathematical explanations (even though these references studiously avoid specific mention of the Pythagorean school or any of its individual members), Aristoxenus' familiarity with their methodology is confirmed. The fact that they are not openly criticised, unlike others who have attempted musical analysis, is perhaps testament to his respect for his former teachers. In the light of Aristoxenus' much expressed regard for the Pythagorean school and way of life, therefore, we must discover why he turned his back on their musical techniques.

Taking into consideration that Aristoxenus aimed to describe music as it was heard, and that the Pythagoreans made committed attempts to incorporate not only the intervals but also some tuning techniques of practical music into their calculations, Aristoxenus' apparent disregard of their theories is noticeable. In general he is eager to take an opportunity to point out the failings of other scholars, although he is somewhat selective about whom he accepts as his predecessors. He criticises the *harmonikoi* for their lack of demonstration and incomplete treatments of their subject, saying for example that no-one had treated any genus other than the enharmonic, but he apparently treats as irrelevant the calculations of Archytas, who gives ratios for all three genera, and of Plato's *Timaeus*, which defines a form of the diatonic.⁴³

In Book I of the *Harmonics*, although he ignores their tetrachordal analysis, Aristoxenus does appear to refer to acoustic theories of the early Pythagoreans, but only in order to establish their irrelevance. When Aristoxenus defines pitch, he mentions such physical theories, noting: ὁ μὲν οὖν βουλόμεθα λέγειν τὴν τάσιν σχεδὸν ἐστὶ τοιοῦτον οἶον μονή τις καὶ στάσις τῆς φωνῆς. μὴ παραττέωσαν δ' ἡμᾶς αἱ τῶν εἰς κινήσεις ἀγόντων τοὺς φθόγγους δόξαι καὶ καθόλου τὴν φωνὴν κίνησιν εἶναι φασκόντων.⁴⁴ It is possible that here he has in mind Archytas' speculations on the relationship between pitch, volume and force.⁴⁵

He also mentions a discussion of his own which has not come through to us, in which the movement of the voice is more fully and clearly examined, ἐν ἄλλοις δὲ ἐπιπλεῖόν τε καὶ σαφέστερον διώρισται (12.32–33). This may refer to a work on the physics of sound, and indicates that he was aware of acoustic theories and was capable of a more expansive discussion of the subject, but that he considers it irrelevant to harmonics proper. Part of Aristoxenus' purpose in his treatise is the strict delineation of the contents of the science of harmonics, and he is determined, having defined it, to exclude that which is irrelevant.

A more direct reference to Pythagorean thought comes in Book II in a section which sets out again Aristoxenus' intended methodology and defends his rejection of mathematical expression. His rationalisation is based on the fact that we do not perceive musical sound as ratios or relative speed.⁴⁶ He does not argue that the Pythagorean calculations of ratios are false or inaccurate, but that they are irrelevant, since even if they are true of unperceived physical events, they do not represent musical relations as these are grasped in auditory experience. With a specific mention of ratios at 32.24, Aristoxenus clearly refers to Pythagorean methods, though he does not name them. His comments on mathematical techniques assure us of his familiarity with these theories and his own self-imposed empirical imperative.

Despite his evident familiarity with Pythagorean musical theory, Aristoxenus excludes their discussions from his treatise. The reason for this exclusion will be discussed in the following chapter as we see how Aristoxenus restricts himself from the use of mathematical theories because he accepts an Aristotelian theory of natural science. In the following section, however, we are to examine some non-mathematical approaches to harmonic science which preceded Aristoxenus' *Harmonics*.

2. EMPIRICISM

There was another major group interested in the science of harmonics before Aristoxenus. These authors applied empirical techniques to the subject and Aristoxenus grudgingly acknowledges them as his predecessors. He grants their work little credit and, although he mentions them several times in his treatise it is, for the most part, in order to criticise their musical theoretical attempts as misguided or incomplete.

Referred to by Aristoxenus as οἱ καλούμενοι ἁρμονικοί (40.26) the group has been shown by Barker not to be a defined school,⁴⁷ but to cover any of those working on musical theory outside a Pythagorean framework. Nonetheless, Wallace⁴⁸ has sought to distinguish divisions within this category. He argues that when Aristoxenus uses the term, it refers to a specific

group who made use of *katapyknosis* diagrams (27.34–28.6) and sought to describe certain musical scales and systems. In the works of some other authors, the term could also refer to those philosophers concerned with the doctrine of ethos and with whose theories Aristoxenus did not disagree.⁴⁹

It is this first group of *harmonikoi* with which we are concerned here. The bulk of the information we have about them is contained in Aristoxenus' treatise itself; thus it is primarily through his comments that we can speculate on the nature of their investigations. Unlike the (indirect) criticism of the Pythagoreans, Aristoxenus does not object to their reliance on audible phenomena. Rather, he complains that they do not cover sufficient material concerning musical structures and that, of the material they do present, they lack demonstration (ἀπόδειξις).

References to these theorists elsewhere in the ancient world are vague and brief. Aristotle mentions them on several occasions: in the *Posterior Analytics* (78b39–79a1), he compares the difference between mathematical harmonics and harmonics according to hearing (ἡ κατὰ τὴν ἀκοήν), noting that the science based on perception knows the fact that something happens, and mathematical harmonics knows the reason why. Another reference occurs in the *Topics* (107a16–17) which notes that the *harmonikoi* concerned with numbers (οἱ κατὰ τοὺς ἀριθμοὺς ἁρμονικοί) assert that a high-pitched or 'sharp' (ὀξεῖα) sound is one that is swift (ταχεῖα).⁵⁰

Theophrastus also mentions the *harmonikoi* when he argues in favour of a qualitative rather than a quantitative perception of intervals.⁵¹ He is critical of those (mathematical theorists) who support ratio expressions of intervals and of those who consider the *harmonikoi* (who judge intervals by perception) as less intelligent than those who judge by ratios. This is not to be mistaken for Theophrastus' approval of *harmonikoi*. Later on in the passage, he argues against judging the differences of sounds by the intervals between them: οὐδὲ γὰρ τὰ διαστήματα, ὥς τινὲς φασιν, αἴτια τῶν διαφορῶν, διὸ καὶ ἄρχαί, ἐπειδὴ καὶ τούτων παραλειπομένων αἰεὶ διαφοραί· οὐ γὰρ ὧν παραλειπομένων γίνεται τάδε αἴτια τοῦ εἶναι οὐχ ὥς ποιοῦντα, ἀλλ' ὥς μὴ κωλύοντα.⁵²

Their methods appear to have initiated the geometrical expression of musical pitch which Aristoxenus developed in his own work.⁵³ In it, pitch is understood within a geometrical framework: two notes can be compared by the distance between them. Therefore, in the same way as the space between two points on a line is capable of accepting a potentially infinite number of points, the space between the limits of any interval is also capable of accepting an infinite number of pitches. Thus, unlike in the Pythagorean approach to music, no interval can be rejected as unmusical on the basis of irrationality

because the relationship between notes is not defined as a ratio but as multiples of a particular unit of measurement. In this method of describing musical structures, then, it is possible to conceive, for example, the interval of a fifth as three and a half tones without reference to the ratio of 3:2 and in this way it is more compatible with the way that the human mind perceives music. Likewise the difficulty which plagued the Pythagoreans in dividing epimoric intervals equally is avoided; a semitone could be perceived as an interval half the size of a tone.

The possibility of establishing the smallest interval perceptible to the hearing and using it as an absolute unit of measurement for all other intervals seems to have been an issue for debate amongst some empirical theorists. Plato is probably referring to the methods of *harmonikoi* when he ridicules a group listening intently for atomic intervals (πυκνωμάτα), as though they were eavesdropping.⁵⁴ For many *harmonikoi* the accepted interval of measurement was the *diesis*, or the quarter-tone, while Aristoxenus tended to use the tone.

From Aristoxenus' treatise and the various other sources named above we can gather that the *harmonikoi* described a limited number of musical structures in the enharmonic genus and within the range of an octave. In order to describe the relationships between *harmoniai*, they employed *katapyknosis* diagrams, which appear to have set out the interval series of different scales in an overlapping arrangement so that the entire system could be depicted within a single octave.⁵⁵ However, there are other techniques described by Aristoxenus and vaguely attributed to empirical theorists which indicate that there was no strictly defined programme for non-mathematical harmonic science.

Aristoxenus' criticism of these non-Pythagorean theorists is mainly concentrated in the first section of the first book of the *Harmonics* and returns again at the beginning of the second book, first with some general comments (32.28–31), then in more detail (35.1–43.23). Both times his condemnation is thinly disguised as a summary of earlier scholarship in the subject. However, the points made against the *harmonikoi* serve to delineate Aristoxenus' conception of what the science of harmonics consists, or rather of what it does not. He is quite emphatic about not including material outside his science, which should only discuss whatever tends towards the science of the *systemata* and the *tonoi*, ὅσα συντείνει πρὸς τὴν τῶν συστημάτων τε καὶ τόνων θεωρίαν (1.20), and more concisely is defined later as the science concerning all melody, τὴν θεωρίαν περὶ μέλους παντός (32.10–11).

Specifically, in the introductory section of the first book Aristoxenus criticises the following points about the *harmonikoi*: that they only focused on the enharmonic genus and the octave interval (2.8–25); that they had not defined the features of the voice and its different movements (3.6–20); that they

did not discuss the genera and the ranges of the moveable notes (4.25–27), nor did they discuss *systemata* and the way that intervals are combined (4.33–5.6), nor how many and what kind of *systemata* exist (5.33–6.11); and that they used *katapyknosis* diagrams (7.22–32). More specifically he mentions the names of Lasus and followers of Epigonus (3.20–23) for their flawed concept of the nature of a note. Aristoxenus does admit that the school of Eratocles (6.13–32) made an attempt to discuss the *systemata*, and that he did enumerate the possible arrangements of the octave, but he condemns his lack of systematic inquiry and his failure to extrapolate from this possible universal laws of melody. In Book II there is a similar specific mention of the followers of Pythagoras of Zacynthos and Agenor of Mytilene (36.33–37.1) who, like Eratocles, attempted to discuss and compare the *systemata* but failed because they did not include all the material necessary for such an enquiry.

The introductory passage of Book II, which again combines criticism of predecessors and an agenda for his work, is considerably better organised and it does not focus so much on the individual sins of the *harmonikoi* until after a general summary. Aristoxenus first sets out his own essential principles for the science of melody, quickly moves on to dismiss mathematical-physical theories as extraneous to harmonics, then criticises the *harmonikoi*: οἱ δ' ἀποθεσπίζοντες ἕκαστα ἄνευ αἰτίας καὶ ἀποδείξεως οὐδ' αὐτὰ τὰ φαινόμενα καλῶς ἐξηριθμηκότες.⁵⁶ There are extensive similarities with the first exposition, such as the criticism of lack of explanation and the unsatisfactory and incomplete enumeration of the genera, of notes and of *systemata*, but now Aristoxenus highlights how his predecessors have failed in relation to each part of harmonic science.

Criticism specific to Book II notes the arbitrary nature of and the inconsistency between the descriptions of the *tonoi* by the *harmonikoi*: ἀλλὰ παντελῶς ἔοικε τῇ τῶν ἡμερῶν ἀγωγῇ τῶν ἁρμονικῶν ἢ περὶ τῶν τόνων ἀπόδοσις, οἷον ὅταν Κορίνθιοι μὲν δεκάτην ἄγωσιν Ἀθηναῖοι δὲ πέμπτην ἕτεροι δὲ τινες ὀγδόην. οὕτω γὰρ οἱ μὲν τῶν ἁρμονικῶν λέγουσι βαρύτετον μὲν τὸν ὑποδώριον τῶν τόνων, ἡμιτονίῳ δὲ ὀξύτερον τούτου τὸν μιξολύδιον, τούτου δ' ἡμιτονίῳ τὸν δωρίον, τοῦ δὲ δωρίου τόνῳ τὸν φρύγιον, ὡσαύτως δὲ καὶ τοῦ φρυγίου τὸν λύδιον ἐτέρῳ τόνῳ· ἕτεροι δὲ πρὸς τοῖς εἰρημένοις τὸν ὑποφρύγιον αὐλὸν προστιθέασιν ἐπὶ τὸ βαρὺ, οἱ δὲ αὖ πρὸς τὴν τῶν αὐλῶν τρύπησιν βλέποντες τρεῖς μὲν τοὺς βαρυτάτους τρισὶ διέσεσιν ἀπ' ἀλλήλων χωρίζουσιν, τὸν τε ὑποφρύγιον καὶ τὸν ὑποδώριον καὶ τὸν δωρίον, τὸν δὲ φρύγιον ἀπὸ τοῦ δωρίου τόνῳ, τὸν δὲ λύδιον ἀπὸ τοῦ φρυγίου πάλιν τρεῖς διέσεις ἀφιστᾶσιν, ὡσαύτως δὲ καὶ τὸν μιξολύδιον τοῦ λυδίου. τί δ' ἐστὶ πρὸς ὃ

βλέποντες οὕτω ποιεῖσθαι τὴν διάστασιν τῶν τόνων προτεθύμηνται, οὐδὲν εἰρήκασιν.⁵⁷ This passage indicates very clearly the confused state of harmonics before Aristoxenus.⁵⁸ It is probable that he himself did much to organise the theoretical arrangement of musical space, creating an integrated system perhaps at the expense of understanding the nature of the individual *harmoniai*.

Also specific to Book II are the descriptions of two other “flawed” conceptions of the subject. These two are quite different from the approaches either of the Pythagoreans or of those who enumerate octave species or organise *dieses* into *katapyknosis* diagrams: ἃ δὲ τινες ποιοῦνται τέλη τῆς ἁρμονικῆς καλουμένης πραγματείας οἱ μὲν τὸ παρασημαίνεσθαι τὰ μέλη φάσκοντες πέρας εἶναι τοῦ ξυνιέναι τῶν μελωδουμένων ἕκαστον, οἱ δὲ τὴν περὶ τοὺς αὐλοὺς θεωρίαν καὶ τὸ ἔχειν εἰπεῖν τίνα τρόπον ἕκαστα τῶν αὐλομένων καὶ πόθεν γίγνεται.⁵⁹ The notation, which Aristoxenus discusses at some length (39.3–41.24), is not that which was transmitted by Alypius,⁶⁰ since it is criticised for giving no indication of the genera, or the positions of the notes in the scale, but only indicates the magnitudes of the intervals. Of what it does consist is difficult to tell.⁶¹ Aristoxenus rejects the notion that it is even part of the study of harmonics, and objects in particular that it does not incorporate signifiers for the function of the notes in the system. As we shall see in the third chapter, the main structural concept of harmonics developed by him is based around *dynamis*, where the precise magnitude of intervals is less important than the position of notes within the system as a whole. A notation which cannot express this is useless to Aristoxenus’ definition of harmonics.

The second method which Aristoxenus dismisses concerns the possibility of harmonic attunement being an inherent property of an instrument (41.26–43.24). Tuning, in an instrument, is subject to variation and depends on the performer for its adjustment; if it were not so, he argues, ἅμα τ’ εἰς τοὺς αὐλοὺς ἀνῆχθαι τὸ μέλος καὶ εὐθὺς ἀστραβὲς εἶναι καὶ ἀναμάρτητον καὶ ὀρθόν.⁶² Those approaching the subject in this way may be the group referred to previously, who, in their work on instruments (35.9), did discriminate the genera perceptually but did not define particular nuances of genera or characteristics of melodic styles in general. It is also possible that these are distinct groups differentiated by their approaches, the one mentioned at 41–42 focusing on the physical characteristics of the instrument, the other on performance practice.

In summary, in Book II Aristoxenus mentions a range of harmonic treatments, including mathematical theories, those dealing with the organisation of the *tonoi*, those concerned with notation and those based upon instruments.

The scope of the criticism is broader than that of Book I (where it focuses mostly on the methods specific to the *harmonikoi*) and covers various approaches to the study of harmonics, as Aristoxenus dismisses their credibility in order to define and defend his own concept of the subject.

CONCLUSION

From the rejection of Pythagorean theories and the criticism of the methods of the *harmonikoi* and others, we can begin to see the criteria on which Aristoxenus has based his study of harmonics. Aristoxenus insists that there are elements which must be included in such a study in order to make it complete, and those which must be omitted as irrelevant. He develops and refines his harmonic science from various sketchy, early excursions into the subject by different authors, making a point of excluding certain techniques which have previously been thought relevant, indeed central, to harmonics—such as the analysis of ratios, of melodic units of measurement, of instruments, performance or notation. Further, Aristoxenus establishes that it is not merely a question of selecting the appropriate elements of analysis; the subjects must be treated thoroughly, include demonstration and explanation, and be consistent with how music is perceived. What he does consider necessary to the science is described most coherently in the second book.

From Book I to Book II of the *Harmonics*, Aristoxenus has refined slightly his list of what should be included in the study of harmonics, with the second version including melodic composition. By working through his own criticisms of the *harmonikoi*, Aristoxenus has organised his own thoughts on the contents of the science. In the second version of this exposition Aristoxenus gives a few general comments on the aims of harmonics and his methodology, and then the parts of harmonics themselves dictate the structure of the passage as each element is presented in order with the relevant mistakes of previous theorists.

In many respects, Aristoxenus has constructed the expositional sections of his work around criticism of his predecessors. While in Book I the *harmonikoi* are the subject of numerous complaints, there are also vague references to some acoustic theories of the Pythagorean school. In Book II, both the *harmonikoi* and the Pythagorean school (obliquely) are criticised in a brief methodological summary, and the *harmonikoi* are again regularly maligned in the enumeration of the seven parts of harmonic science. Additionally, perhaps for the sake of completeness, other types of theories are dismissed as irrelevant, including that promoting notation, and those reliant on instruments. Thus the delimitation of harmonics as defined by Aristoxenus owes a great deal to the perceived errors of his predecessors.

Having defined the essential components of his science in the introductory sections of Books I and II, and having expanded on his conception of harmonics in the development sections, Aristoxenus is then able to apply this material in the third book of the treatise to an attempted set of axioms about musical structures.

In this chapter we have acknowledged the negative influences on Aristoxenus, that is musicological techniques which he has criticised, modified, expanded or rejected, and how he attempted to organise his science after the rejection of arithmetical definitions of musical space. Aristoxenus does make use of mathematical concepts—he would have difficulty describing his tetrachord divisions without some numbers—but they are not the defining framework of his treatise. His science emphasises the depiction of *dynamis* which he develops as he works against previous scholarship. In the next chapter, we shall examine a more positive influence, that of Aristotle.

Chapter Two

The Influence of Aristotle on Aristoxenus' Harmonic Science

INTRODUCTION

Aristoxenus criticised or rejected the techniques of almost all his predecessors in the field of harmonics, yet it was not merely in reaction to them that the careful methodology of his treatise was constructed. The work is organised in such a way as to indicate a purpose of construction which goes beyond a mere series of diatribes against earlier scholarship. Under what influence, then, did Aristoxenus develop this structure? Because he left his Pythagorean teachers for the Lyceum, and because he rejected Pythagorean musical methodology, Aristotle's work is the obvious place to look. However, as Aristotle himself had no real musical expertise, and the Peripatetic school in general did not produce work on music even close to Aristoxenus' *Harmonics* in theoretical structure and discipline, this influence was clearly not in the form of a direct adoption of musical methodology. Rather, Aristoxenus has appropriated techniques of scientific discussion promoted by Aristotle in subjects other than music, and applied them to harmonics. This is most evident in Aristoxenus' defining ambition of developing an independent science from first principles.

1. THE LYCEUM

1a. Aristotle and Music

Although Aristotle was not a musical expert, and devoted no single work to music, the subject appears in several passages of his writings. The most extended discussion, in Book VIII of the *Politics*, focuses on non-technical aspects of music, particularly its role in education and society.¹ Elsewhere, references to music theory are employed particularly to illustrate general

points in an extra-musical context. Information about Aristotle's understanding of harmonics is often found in such passages where, for example, the relationship between harmonics and arithmetic is compared to that between optics and geometry,² or a mixture of concordant sounds is compared to a mixture of colours.³ On a theoretical level, Aristotle generally adopted a Pythagorean view of musical space based on the numerical relationships of intervals. At the same time, he did not dispute an empiricist methodology based on the scale systems of musical practice, and in some passages it must be understood from the context that he has assumed this approach. Furthermore, an empirical method is combined with the Pythagorean doctrine in Aristotle's discussions on the physics of sound, on the sense of hearing, and in particular on how consonant intervals are perceived.⁴

That Aristotle had some knowledge of music is clear from his use of technical terms in incidental references and examples. He uses harmonics as an example for the observation that there are two levels to some sciences, that based on mathematics and that based on perception: ἐνταῦθα γὰρ τὸ μὲν ὅτι τῶν αἰσθητικῶν εἰδέναι, τὸ δὲ διότι τῶν μαθηματικῶν οὗτοι γὰρ ἔχουσι τῶν αἰτίων τὰς ἀποδείξεις, καὶ πολλάκις οὐκ ἴσασι τὸ ὅτι, καθάπερ οἱ τὸ καθόλου θεωροῦντες πολλάκις ἔνια τῶν καθ' ἕκαστον οὐκ ἴσασι δι' ἀνεπισκεψίαν.⁵ In fact, Aristotle has neatly summed up the disadvantages of the two methods of harmonics. The empirical approach of the *harmonikoi* avoided the mathematical problems involved in representing consonant intervals with superparticular ratios, while the greater accuracy of the Pythagorean theorists gave no concept of the way in which melody is understood by the listener. However, Aristotle himself did not always distinguish clearly between these approaches, and his insufficient understanding of their differences is apparent in his lack of consistency when referring to musical issues.

For example, he assumes at his convenience mutually exclusive definitions of the *diesis* and ignores the implications of their methodological foundation. In a passage in the *Metaphysics* the *diesis* is considered first as a unit of measurement (ἡ ἀρχή) approximating a quarter-tone.⁶ Aristotle here reflects the approach of the *harmonikoi*, particularly in their use of *katapyknosis* diagrams in which intervals are measured as multiples of the *diesis*, or in which scale systems are mapped out on a line of consecutive *dieses*. In a discussion of measurement, Aristotle compares the *diesis* to the unit of measure in other sciences: ἀρχὴ καὶ μέτρον . . . καὶ ἐν μουσικῇ δῖεις, ὅτι ἐλάχιστον, καὶ ἐν φωνῇ στοιχείον.⁷ This passing reference is typical in its assumption of basic technical musical knowledge on the part of the reader, despite the discussion's general scientific subject.

Less than five lines later, we find a description of the *diesis* more suitable to Pythagorean theory because it refers to ratios, but Aristotle has unfortunately incorporated the empirical notion of a unit of measurement into the concept of measuring intervals by ratio: οὐκ ἂν δὲ τῷ ἀριθμῷ ἐν τῷ μέτρῳ ἀλλ' ἐνίοτε πλείω, οἷον αἱ διέσεις δύο, αἱ μὴ κατὰ τὴν ἀκοὴν ἀλλ' ἐν τοῖς λόγοις.⁸ He initially refers to the *diesis* of empirical science, which is of a consistent size, then claims that there is more than one *diesis*, thereby involving more than one unit of measurement.⁹ While Pythagoreans did use two different epimoric ratios to define their *dieses* within a single tetrachord, neither of these intervals is understood to be commensurable with the other, nor with the remaining larger interval of the tetrachord.

This difficulty perhaps requires some digressive explanation, particularly as it demonstrates that Aristotle's grasp of the concepts of Pythagorean musical theory is less than perfect, and possibly that the mathematical processes involved in this theory were not sufficiently established by this time to be understood by those who were not experts in the field. It is clear that the implications of a ratio-based definition of intervals preclude a unit of measurement, and that this was overlooked by Aristotle. If, for example we take a tetrachord of the enharmonic genus with the upper interval of 5:4, the remaining *pyknon* of 16:15 (approximately a semitone) can be divided into two approximate quarter-tones, or *dieses*.¹⁰ Archytas, a generation earlier, proved that epimoric intervals cannot be divided equally,¹¹ necessitating the use of either an harmonic or an arithmetic mean, rather than a geometric mean, to obtain two as-equal-as-possible epimoric intervals. The division in this case of 16:15 by the harmonic mean results in two *dieses*—precisely measured but of different sizes—of 31:30 and 32:31, neither of which can be “the measure” for the other intervals of the tetrachord. To be able to have two *dieses* of the same size would imply that the epimoric intervals of melody could be divided equally, the impossibility of which is an essential tenet of Pythagorean theory.

However, it is perhaps unreasonable to criticise Aristotle for his confusion. The enharmonic example cited above is attributed by Ptolemy to Didymus,¹² and cannot with any certainty be dated before the first century CE, although it may have been defined earlier. Unfortunately, of the few tetrachordal divisions surviving from before Aristotle, only those of Archytas apply his proof of the impossibility of equally dividing epimoric ratios, and the consequent application of the harmonic mean. However, his divisions are not very helpful in the matter of the *diesis*: his enharmonic *pyknon* of 16:15 is divided into two epimoric intervals 28:27 and 36:35, and does not make use of the harmonic mean, which would divide the *pyknon* as in Didymus' tetrachord cited above. As the lowest interval is the same in all Archytas' genera,

the 9:8 tone of the chromatic *pyknon* is divided into *dieses* of 28:27 and 243:224, and the remaining interval is then 32:27, making only one interval of the tetrachord epimoric. As we commented in the previous chapter, all the pitches of Archytas' three divisions put together can be obtained entirely by epimoric intervals of numbers less than ten, yet not all the intervals created conform to the epimoric criterion later demanded by Pythagorean theorists. Despite the mathematical techniques available to him, possibly even established by him, Archytas was not inclined to apply the harmonic mean with such rigour as to obtain only epimoric intervals.

If we accept the possibility that, before Archytas, Philolaus proposed a division of the enharmonic tetrachord, we can deduce from Boethius' evidence that it would have consisted of an upper interval of 81:64 (a true ditone, but not epimoric) and a *leimma* (or *diesis* as Philolaus called it) of 256:243 divided equally into two *diaschismata*. The two *dieses* in this case would be even, thereby contradicting Aristotle's contention of two different *dieses* in ratio theories, and not commensurable with the ditone interval. It is noticeable in Boethius' account that there is no attempt to define these small intervals by ratio.¹³ The differences between this assumed division of Philolaus and the more sophisticated calculations of Archytas suggest that in the time of Aristotle the mathematical solutions which were developed to deal with the problems of Pythagorean harmonic theory had been defined, but not systematically applied to the tetrachordal divisions which had presented the original problem.

The only other pre-Aristotelian evidence for the mathematical division of musical space is the calculation for the standard Pythagorean diatonic tetrachord featured in the extra-musical context of Plato's *Timaeus* (36a-b).¹⁴ Although Plato uses the harmonic and arithmetic means¹⁵ in his cosmological discussion, he offers no calculation which could be representative of an enharmonic or a chromatic tetrachord, and the diatonic division which he does offer is a consequence of musical practice expressed in mathematical language rather than a theoretical reflection on the application of the harmonic mean.

Consequently, it appears that the material available to Aristotle on the rational division of harmonic space was limited. With his incomplete understanding, he often made use of musical terminology, but in each passage, depending on the point illustrated, he varied or sometimes just confused the methodological basis implied. While he was happy to represent the *diesis* as the empirical unit of measurement in melody, he also referred to mathematical ratio theory both for the *diesis* and for the consonant intervals and the tone.¹⁶ It seems likely that the mathematical developments necessary to apply

these distinctions fluently were not emphasised or applied in relation to music until the appearance of the Euclidean treatise on the division of the canon around 300 BCE, at least 20 years after Aristotle's death. This mathematically-based work clearly and systematically elucidates the essential principles of Pythagorean harmonic theory. Yet even this does not focus on the full range of possibilities for tetrachordal division and only defines the diatonic tetrachord (Propositions 19 and 20) and alludes to an enharmonic (Propositions 17 and 18) of which the true ditone interval is established by concords and whose *pyknon* of 256:243 is said not to be divided equally, but is not granted a numerical division.

The Ps.-Plutarchean *De Musica* attributes to Aristotle a musical familiarity which is in accordance with this superficial exposure to mathematical theories. In it, Aristotle is seen to maintain a more consistent Pythagorean mode of thought but keeps the calculations involved at a very basic level. Chapter 23 (1139b-f) contains a superficial technical discussion of musical structures, including such fundamental concepts as the tetrachord and the names of the notes. More importantly, it defines the numerical ratios of the three consonances and the tone, and their positions in the scale, and has a fairly laboured discussion of the arithmetic and harmonic means involved. The basic nature of the musical mathematics here is in accordance with the limited knowledge demonstrated by Aristotle, but its simplistic exposition equally could suggest a secondary hand. Even if Ps.-Plutarch's attribution is misguided, there is sufficient evidence elsewhere for Aristotle's acceptance of a mathematical representation of melody, but not for a profound discussion on the division of the tetrachord.

Despite Aristotle's preference for mathematical ratios as a methodological technique of harmonics, he did not subscribe to the cosmological implications which appear in Pythagorean theory.¹⁷ His comments on the Pythagorean school have been noted in the previous chapter, and in particular his disagreement with the Pythagorean equation of things with numbers. He accepted the arrangement of ratios in a musical context, which can be confirmed through experiment,¹⁸ but rejected using this to justify speculation on a hypothetical numerical organisation of the universe. In the *Metaphysics*, he dismisses the notion that quantity is the cause of things, citing the unrelated form of certain objects despite their numerical similarity; the seven vowels, the seven strings of the scale, the seven Pleiades, the age at which animals lose their teeth (seven, apparently) and the Seven against Thebes. As a musical example, he points to the association by some people of the double consonants Ξ, Ψ and Ζ with the concords, purely on the basis that there are three each of them. In each case, Aristotle insists that number itself cannot be the cause: "ἔτι

οὐχ οἱ ἐν τοῖς εἶδεσιν ἀριθμοὶ αἴτιοι τῶν ἀρμονικῶν καὶ τῶν τοιούτων (διαφέρουσι γὰρ ἐκεῖνοι ἀλλήλων οἱ ἴσοι εἶδει· καὶ γὰρ αἱ μονάδες)· ὥστε διὰ γε ταῦτα εἶδη οὐ ποιητέον.¹⁹ While the ratio-based depiction of musical space was accepted by Aristotle, then, the cosmological implications developed by the Pythagoreans were not.

In addition to these incidental examples Aristotle used musical phenomena to exemplify the nature of perception. The discussion in *De Sensu* is confusing, but clearly indicates an empirical agenda despite referring to the mathematical ratios of intervals, particularly of consonant intervals.²⁰ Aristotle claims that it is easier to hear a single note than a mixture of two notes, and says: οὐδὲ τὰ μεμιγμένα ἅμα (λόγοι γάρ εἰσιν ἀντικειμένων, οἷον τὸ διὰ πασῶν καὶ τὸ διὰ πέντε), ἂν μὴ ὥς ἐν αἰσθάνηται.²¹ He suggests that a concord is perceived as a single sound because the notes of such ratios are so well blended, and therefore the unquestioning acceptance of the rectitude of Pythagorean rational theory functions as a short cut in the explanation to his empirical observations based on this assumption. However, the origin and role of the theory about the elevated status of consonances in pre-Aristotelian thought is uncertain. Barker points out that this concept of concord as a unity “reflects the commonest of the definitions of musical concord given by the Greek theorists.”²²

As we can see, Aristotle’s discussions on music were not technical, or at least only superficially so, and while he generally assumed a Pythagorean standpoint on harmonic theory, he did not condemn an empirical one of the type associated with variously identified *harmonikoi*. Indeed mathematical arguments are used to confirm empirical observations. Both perspectives are included in his passing references to harmonics, the mathematical ratios of intervals from the former, and the *diesis* as unit of measurement from the latter. Apart from the discussion of the educational and social role of music in the *Politics*, Aristotle applied his musical knowledge mostly in order to demonstrate general scientific points, and in this he assumed a basic familiarity with musical terminology in his audience.

1b. The Peripatetic School

Although Aristotle did not devote any particular work to music, other scholars of his school did. In general research, the dominant Peripatetic method involved a systematic gathering of previous work into the *synagoge*, in which material on a common theme was collected. This method encouraged a communal attitude, stressing the priority of accumulating and cataloguing knowledge.²³ This technique is theoretically justified in the above-noted description of Pythagorean scholarship given by Aristotle in the *Metaphysics*, in

which he indicates the cumulative nature of scholarship: ἡ περὶ τῆς ἀληθείας θεωρία τῇ μὲν χαλεπῇ τῇ δὲ ῥαδίᾳ. σημεῖον δὲ τὸ μήτ' ἄξιως μηδένα δύνασθαι θιγεῖν αὐτῆς μήτε πάντας ἀποτυγχάνειν, ἀλλ' ἕκαστον λέγειν τι περὶ τῆς φύσεως, καὶ καθ' ἓνα μὲν ἢ μηθὲν ἢ μικρὸν ἐπιβάλλειν αὐτῇ, ἐκ πάντων δὲ συναθροιζομένων γίγνεσθαι τι μέγεθος.²⁴ The object of this scholarly view was to establish an encyclopaedic knowledge of the world based on the collection of data from as many sources as possible, but not on systemisation of a pre-conceived theory deduced from reason.²⁵ This is perhaps one reason why Aristotle rejected the application of the number relationships in musical structures to a cosmological system.

A few writings from the Peripatetic school include extended technical references to the science of harmonics. The *De Audibilibus*, partially preserved in Porphyry's *Commentary on Ptolemy's Harmonics*, was attributed by Porphyry to Aristotle himself, but is actually the work of one of his students, probably Strato.²⁶ It covers the physical nature of sound production, particularly factors of pitch and tone, by using examples of sonorous sources such as horns, *auloi*, *salpinges*, stringed instruments and voices, and develops the theory that sound consists of multiple impacts.²⁷

Also preserved by Porphyry is a passage of Theophrastus' *On Music*, in which he dismisses the numerical explanation of harmonics: καὶ γὰρ εἰ πᾶν διάστημα πλήθος τι, τὸ δὲ μέλος ἐκ διαφορῶν φθόγγων, τὸ μέλος ὅτι ἀριθμὸς τοιόνδε ἂν εἴη· ἀλλ' εἰ μηδὲν ἄλλο <ἢ> ἀριθμὸς, πᾶν ἀριθμητὸν μετέχει ἂν καὶ μέλους, ὅσον καὶ ἀριθμοῦ.²⁸ He concludes that there must be a difference of quality rather than quantity between sounds of different pitch. This rejection of numerical significance is similar to Aristotle's statement in the *Metaphysics*²⁹ that there must be a difference between the essential matter of sound and other objects, since a numerical similarity is insufficient for an association. Theophrastus differed from his teacher in that he demanded a qualitative difference between pitches, and did not accept even within the same genus that a quantitative difference could suffice. There may possibly be some connection here with the position held by Aristoxenus, that musical comprehension cannot exist based only on interval measurements, since the dynamic function of notes must also be included. Theophrastus also contributed a practical discussion in his *Historia Plantarum* which describes the making of *auloi* from reeds,³⁰ thus exemplifying the encyclopaedic nature of Peripatetic scholarship.

The third major passage of Peripatetic musical theory is the *Ps.-Aristotelian Problemata*, a series of questions with tentative answers on a wide range of subjects, of which two books (XI and XIX) focus on music. Repeated questions with contradictory answers suggest that the material

was collected from several sources. The topics include speculation on the production of sound as well as issues related to musical practice, such as the characteristics of concords. With a commitment to Pythagorean theory similar to Aristotle's, the treatise refers to specific musical experiments (such as with vases) and the relationships of intervals and their ratios. These discussions place intervals in the context of their position in the scale and acknowledge the dynamic value of how they were perceived by the listener. The point is not really developed, perhaps owing to the limited nature of the format. There are also questions with a sociological slant providing considerable information on the performance of Greek music. As in Book VIII of Aristotle's *Politics*, the text refers to the ethos and the social function of certain types of music. In general, the *Problemata* demonstrate a high level of fluency with the terms of empirically-based (but non-Aristoxenian) music theory but are also familiar with sociological discussion and mathematical perspectives.

Investigation into musical phenomena in the Peripatetic school emphasised acoustics, i.e. the production and perception of sound, but did so generally from a Pythagorean perspective. Familiarity with technical terminology was often assumed in the audience,³¹ and the end approach was typically Aristotelian, developing already established ideas, and collecting and recording information for reference. On the other hand, although Aristoxenus had considered himself such a central figure of the school that he could be a candidate for its leadership,³² he took a different approach to musical investigation. He rejected this cumulative nature of research in the *Harmonics*, refusing to acknowledge physical-mathematical theories, or to recognise much value in the discussions of the *harmonikoi*. Indeed, he was very conscious of his role as an innovator in a science effectively untouched by other researchers owing to what he saw as the irrelevance and incompetence of their research. Because of Aristotle's lack of commitment to any detailed musical theory, the Peripatetics were free to pursue their own methods. With the notable exception of Aristoxenus, they did not explore radical techniques, for the most part confining themselves to the recording of data or continuing acoustic investigation in a similar style to their teacher.

2. THE SCIENTIFIC METHODOLOGY OF ARISTOTLE

Aristoxenus did not follow a Peripatetic approach of cumulative research in his *Harmonics*, and Aristotle did not provide him with any sort of musical methodology capable of establishing the independent science to which Aristoxenus aspired. Yet Aristotle discussed methods and techniques of scientific investigation in several passages and Aristoxenus appropriated them for

his musical purpose. Most importantly, Aristotle offered a detailed scientific methodology in the course of his *Posterior Analytics*, setting out the characteristics and value of "first principles" from which could be deduced propositions or theorems about a subject.³³ Although there are other influences, Aristoxenus developed his treatise in the terms of a demonstrative science, and the theorems of the third book of the *Harmonics* illustrate the axiomatic ambition of his work.³⁴ The *Posterior Analytics* is, then, the prime representative of the intellectual source of Aristoxenus' musical methodology.

It has repeatedly been argued that there is no existing work of Aristotle which demonstrates the application of his own methodology of science;³⁵ however, in the work of certain of his students his theories are applied. As far back as 1952, Jaeger pointed out the similarity in this respect between Aristoxenus and another Peripatetic scholar, Diocles of Carystus. Both accepted methodological principles as they were outlined in the *Posterior Analytics* and applied them with a diligence unseen in Aristotle, each to his chosen science, one to music, the other to medicine.³⁶ While the biographical information about Diocles may be doubtful, the intellectual influence of Aristotle on Aristoxenus is in this respect clear.

The *Harmonics* broadly realises an adherence to an Aristotelian method, and one of the points which Aristoxenus accepts from the *Posterior Analytics* is the rule of subject limitation.³⁷ This is the limitation of the discussion concerning a particular science to the terms of that science, and is central to Aristoxenus' development of an autonomous study in this field, which explicitly contradicts his teacher's acceptance of harmonics as subordinate to the arithmetic of Pythagorean music theory.³⁸

Aristoxenus also adopts other theories which appear in the *Posterior Analytics*. As we have noted, Aristotle conceives two methods of science: that based on perception and that based on mathematics, the first describing the fact that (something happens) and the other describing the reason why.³⁹ Although Aristoxenus' conception of harmonic science is essentially based on perceptible phenomena, he exploits elements from both methods; accordingly, his emphasis on the empirical basis of harmonic science and the rejection of mathematics are balanced by the value he claims for demonstration (ἀπόδειξις), a process which Aristotle associates with harmonics only in its mathematical form. In this way Aristoxenus attempts to compensate for the lack of explanation in the former by incorporating methodological elements of the latter.

Furthermore, Aristoxenus takes the opportunity to be selective in the application of his teacher's doctrines, choosing from the vast corpus that which suits his purpose. Aristotle's division of science into perception-based

and mathematical-based methods is one variant of the classifications of the subject. He also sets out a three-fold division of science: the productive (ποιητική), concerned with phenomena; the practical (πρακτική), relating to the actual performance of a task; and the theoretical (θεωρητική), the highest form of science, concerned with causes and principles. A passage in the *Metaphysics* sets out this division and describes natural science as a theoretical one.⁴⁰ It is the framework of this science which Aristoxenus adopts, adding to it elements of Aristotle's mathematical science with its emphasis on demonstration. It is worth noting the emphasis Aristoxenus constantly places on the natural forms of melody in his empirical investigation, confirming his conception of harmonics as a natural theoretical science.

In addition, some terms which are used freely in the *Posterior Analytics* and in Aristoxenus' *Harmonics* are treated to extended definitions in the *Physics* and the *Metaphysics*⁴¹ and these contribute to the clarification of Aristoxenus' scientific comprehension. It is clear that Aristoxenus does not just apply Aristotle's method from the *Posterior Analytics* directly to his *Harmonics* but that he accepts into his treatise elements of his teacher's thinking on scientific procedure from a range of areas.

As has been noted, Aristotle's investigation of a subject regularly includes an overview of how the preceding scholarship had developed, as well as its ambitions and its failings. His acknowledgement of this approach is exemplified in his methodological discussion from the *De Anima*: ἐπισκοποῦντας δὲ περὶ ψυχῆς ἀναγκαῖον, ἅμα διαποροῦντας περὶ ὧν εὐπορεῖν δεῖ προελθόντας, τὰς τῶν προτέρων δόξας συμπαραλαμβάνειν ὅσοι τι περὶ αὐτῆς ἀπεφώνησαντο, ὅπως τὰ μὲν καλῶς εἰρημένα λάβωμεν, εἰ δέ τι μὴ καλῶς, τοῦτ' εὐλαβηθῶμεν.⁴² While Aristoxenus follows the letter of this program, the spirit is denied since he refuses to admit the value of any previous studies. Rather than developing an historical or descriptive analysis, references in the *Harmonics* to the work of other theorists tend to deny the relevance of their scholarship through disparaging comments and are designed to emphasise his own innovation.

We can see that, having rejected the encyclopaedic trend of the Peripatetic school, the Pythagorean mathematical techniques in music, and the uncoordinated descriptions of musical space by the *harmonikoi*, Aristoxenus nonetheless develops a methodology based on general Aristotelian scientific methods. Aristotle states from the outset of the *Physics* the necessity of expressing the knowledge about a science through principles: ἐπειδὴ τὸ εἰδέναι καὶ τὸ ἐπίστασθαι συμβαίνει περὶ πάσας τὰς μεθόδους, ὧν εἰσιν ἀρχαὶ ἢ αἷτια ἢ στοιχεῖα, ἐκ τοῦ ταῦτα γνωρίζειν.⁴³ Similarly, Aristoxenus claims his subject is the study of first

principles in Book I of the *Harmonics* (1.19–20).⁴⁴ This is reinforced in Book II as he notes: ἐπεὶ δὲ πάσης ἐπιστήμης, ἥ τις ἐκ προβλημάτων πλειόνων συνέστηκεν, ἀρχὰς προσήκόν ἐστι λαβεῖν ἐξ ὧν δειχθήσεται τὰ μετὰ ἀρχάς, ἀναγκαῖον ἂν εἴη λαμβάνειν.⁴⁵ His conception of harmonics is confirmed as a natural theoretical science through his methodological discussions. Far from writing a practical manual for performing musicians, or a phenomenological description of melody, he attempts to exemplify Aristotle's theoretical science through music. His theoretical rigor is evident in the way that he applies Aristotle's stated method in a manner which his teacher never actualises in his extant works, but he also demonstrates the ability to absorb selectively the useful methods of his teacher's science. Although the musical appropriation of Aristotle's theories occasions many problems, in the main Aristoxenus develops successful techniques to overcome or at least to avoid them.⁴⁶

There are, as we have mentioned, two general ideas which Aristoxenus adopts from Aristotle's scientific theory. The first is the idea of subject limitation which is essential to establish the independence of a science, the other is the programme of natural theoretical science which proceeds from first principles to demonstrated propositions. We shall examine each of them in turn.

2a. Subject Limitation

In the *Posterior Analytics* Aristotle clearly defines the boundaries of any particular science: μία δ' ἐπιστήμη ἐστὶν ἡ ἐνὸς γένους, ὅσα ἐκ τῶν πρώτων σύγκειται καὶ μέρη ἐστὶν ἡ πάθη τούτων καθ' αὐτά.⁴⁷ Accordingly, one cannot explain a phenomenon of one genus by reference to the characteristics of another genus. Because the propositions of a science must be essential and necessary, they must belong to that science per se: οὐκ ἄρα ἔστιν ἐξ ἄλλου γένους μεταβάλλοντα δεῖξαι, οἷον τὸ γεωμετρικὸν ἀριθμητικῇ.⁴⁸ However, Aristotle does not apply this rule to harmonics, and in his references to the subject he emphasises its subordinate relationship to mathematics.

Aristoxenus, on the other hand, following Aristotle's theoretical example, strives to keep his science autonomous and to maintain its limits within the same domain, and he spends a considerable amount of time criticising those who apply extraneous methods to harmonics. As we saw in the previous chapter, these methods include the study of instruments, notation and acoustics, and in particular the theory which reduces musical phenomena to characteristics of numerical relationships. This is in direct contrast with the approach of his master in this matter, who specifically excepts harmonics from the subject limitation rule, principally because he accepts the Pythagorean numerical division of musical space and applies mathematical laws to melody.

Among all these exclusions, Aristoxenus delineates what is included in his science. In Book I of his treatise he notes the nature of harmonics: τυγχάνει γὰρ οὐσα τῶν πρώτων θεωρητική· ταῦτα δ' ἐστὶν ὅσα συντείνει πρὸς τὴν τῶν συστημάτων τε καὶ τόνων θεωρίαν,⁴⁹ and later refers to the future student of the subject as a student *περὶ μέλους* (3.6). Initially, he does not offer much specific information on the methods inappropriate to harmonics but gives a warning about its limits: προσήκει γὰρ μηθὲν πορρωτέρω τούτων ἀξιούν παρ' αὐτοῦ τοῦ τὴν εἰρημένην ἔχοντος ἐπιστήμην.⁵⁰ This last comment deliberately omits composition from this investigation, an omission which Aristoxenus corrects in the revised introduction of Book II. The later exposition of Book II is typically clearer, stating καθόλου μὲν οὖν νοητέον οὐσαν ἡμῖν τὴν θεωρίαν περὶ μέλους παντός, πῶς ποτε πέφυκεν ἡ φωνὴ ἐπιτεινομένη καὶ ἀνιεμένη τιθέναι τὰ διαστήματα.⁵¹

In Book II, once he has defined melody as the limit of harmonics, Aristoxenus establishes a comprehensible structure for the division of musical space, in order that his treatise does not merely describe an uncoordinated series of aural phenomena. Without reference to extraneous principles, this organisation can only be achieved by reference to perception and within a system which acknowledges how melody is understood by the listener.⁵² Perceptual reference is entwined in the essence of melody through the concept of *dynamis* developed in Book II. This gives melody an empirically based structure and removes the need for reference (for instance) to numerical terminology. It is clear that the concept of the tone as the interval difference between a fourth and a fifth is comprehensible in relation to the sense of hearing in a way that the equation $3:2-4:3 = 9:8$ is not.

Just as there are flaws in the Pythagorean expression of musical structures, so problems are created by Aristoxenus' insistence that no understanding of them can be conveyed by quantitative analyses. He cannot avoid some mathematically-based descriptions in his division of the genera; and in some cases their accuracy cannot be assessed by ear. Barker⁵³ has demonstrated that the only intervals which he can actually derive empirically are the semitone and its multiples, despite the fact that he specifies in his tetrachordal divisions third-tones, quarter-tones and three-eighths tones. It is unlikely that, if he cannot measure anything smaller than a semitone, he would be able to distinguish precisely between intervals differing by a twenty-fourth tone.⁵⁴

Aristoxenus in fact makes extensive use of the quarter-tone in his divisions and claims that it is the smallest melodic interval despite the fact that he has no practical method for perceiving its accuracy. He does admit that intervals smaller than this (the sixth-tone and twelfth-tone) are "unmelodic,"

although they are relevant for interval comparison between genera (25.22–25). But for the so-called melodic intervals which create these unmelodic intervals (for example a twelfth tone from the difference between a quarter-tone and a third-tone), he does not make any attempt to establish how these intervals can be accurately differentiated by perception. As his own treatment shows, he is well aware that the differences between such tiny intervals can only be calculated theoretically, and cannot be measured by empirical means.

This fault is alleviated somewhat by the context of Aristoxenus' description. Precise divisions of the genera and their nuances are not central to his depiction of musical space, and perhaps they can be taken as hypothetical guides for the student. He emphasises that perception of each genus is maintained within a certain range, and is not determined by specific pitch points. In Book II, he also emphasises that the function of each note is more important than its precise pitch: ὥστ' εἶναι φανερόν, ὅτι κινουμένων τῶν μεγεθῶν συμβαίνει <διαμένειν> τὸ γένος, οὐ γὰρ ὁμοίως κινεῖται τῶν μεγεθῶν κινουμένων μέχρι τινός, ἀλλὰ διαμένει· τούτου δὲ μένοντος εἰκὸς καὶ τὰς τῶν φθόγγων δυνάμεις διαμένειν.⁵⁵ The reference to the perceived function of the notes ensures that Aristoxenus remains within the harmonic domain, since the numerical guide he provides for genus identification is not essential to his conception of melodic structures.

In order to establish the authority of his science, Aristoxenus demands its independence from other realms of knowledge. He narrows his subject to matters relevant to melody and criticises his predecessors for having failed to do so. He continually emphasises his own innovative approach in rejecting this dependence and seeks to describe musical structures without reference to the mathematical, or any other, sphere. There is some inconsistency in the application of this rule with regard to the description of the genera, but the point does not significantly affect his methodology. As we shall see, his ambition is most satisfactorily achieved in Book II with the concept of *dynamis* and the consideration of the function that each note plays within the musical structure.

2b. Natural Theoretical Science

From the first, Aristoxenus assumes adherence to an axiomatic method for harmonics τυγχάνει γὰρ οὕσα τῶν πρώτων θεωρητική.⁵⁶ The adoption of the notion of first principles is a direct assumption of a type of Aristotelian investigative technique.⁵⁷ Furthermore, Aristotle classifies the science based on first principles as theoretical in the *Metaphysics*, placing it above phenomenal and practical fields of knowledge: ὅτι τὴν ὀνομαζομένην σοφίαν περὶ τὰ πρώτα αἰτία καὶ τὰς ἀρχὰς ὑπολαμβάνουσι

πάντες· ὥστε, καθάπερ εἴρηται πρότερον, ὁ μὲν ἔμπειρος τῶν ὁποιοῦν ἔχόντων αἴσθησιν εἶναι δοκεῖ σοφώτερος, ὁ δὲ τεχνίτης τῶν ἐμπείρων, χειροτέχνου δὲ ἀρχιτέκτων, αἱ δὲ θεωρητικαὶ τῶν ποιητικῶν μᾶλλον. ὅτι μὲν οὖν ἡ σοφία περὶ τινὰς ἀρχὰς καὶ αἰτίας ἐστὶν ἐπιστήμη, δῆλον.⁵⁸

In addition to the science based on principles, it is important to note that in the *Physics*, Aristotle states the necessary progression from principles to elements: τότε γὰρ οἰόμεθα γινώσκειν ἕκαστον, ὅταν τὰ αἷτια γνωρίσωμεν τὰ πρῶτα καὶ τὰς ἀρχὰς τὰς πρῶτας καὶ μέχρι τῶν στοιχείων.⁵⁹ As will be discussed in the following chapter, Aristoxenus also adopts the programme of a progression from principles to elements.

We saw, with regard to Aristoxenus' criticism of the *harmonikoi*, and in other matters, that his exposition becomes clearer between the first and second books. This is also the case with his methodology. In Book I, Aristoxenus seems unsure about the status of his science. He indicates that harmonics is the study of first principles (1.19) which would, according to Aristotle's theory, include it among the theoretical sciences. A little later there is the suggestion that a correct investigation into the subject should include demonstration, also a feature of theoretical science: when Aristoxenus has finished his expository list of what must be discussed in the science of harmonics he complains that no λόγος has been presented on these matters, "with or without demonstration" (οὐτ' ἀποδεικτικὸς οὐτ' ἀναπόδεικτος, 5.22). However, although theoretical science is the most superior, according to the *Metaphysics*,⁶⁰ Aristoxenus claims that there is a higher form of musical science than harmonics, which is that of composition (2.1–2). While he seems committed to presenting a theoretical account of harmonics, the exclusion of composition prohibits its superior status as a science.

This confusion of whether harmonics belongs to the highest level of science is cleared up in the second book. With the conceptual development of Book II, melodic composition is included in harmonic science, indeed it is labelled as its completion (38.18), although its treatment does not survive in the treatise as we have it. It is also in the second book that Aristoxenus' method of harmonics is confirmed as being based on Aristotle's criterion of theoretical investigation: ἡμεῖς δ' ἀρχὰς τε πειρώμεθα λαβεῖν φαινομένας ἀπάσας τοῖς ἐμπείροις μουσικῆς καὶ τὰ ἐκ τούτων συμβαίνοντα ἀποδεικνύειν.⁶¹ Thus, it is only in his second exposition that Aristoxenus combines into one investigation what he previously saw as belonging to two, and is able with certainty to elevate the complete study of harmonics to the highest level of science. It appears that after he had begun

setting down his first book of his treatise, Aristoxenus reconsidered the methodological implications of demonstration from first principles.

Having claimed the natural theoretical status of his science, Aristoxenus has to reconcile its criteria with the realities of his own subject, melody. From the various passages in the Aristotelian corpus in which theoretical science is discussed, we gather that it is knowledge about first causes and primary principles. In the *Posterior Analytics* these principles are described as needing ἐξ ἀληθῶν τ' εἶναι καὶ πρώτων καὶ ἀμέσων καὶ γνωριμωτέρων καὶ προτέρων καὶ αἰτίων τοῦ συμπεράσματος.⁶² From principles, theorems about the subject can be demonstrated.

The claim for the theoretical level of science, rather than a phenomenal or practical level, does not negate Aristoxenus' emphasis on the need for accurate perception of melody. Discussion in the *Posterior Analytics* establishes a link between the perception of a particular object and the knowledge necessary for a theoretical science: αἰσθάνεσθαι μὲν γὰρ ἀνάγκη καθ' ἕκαστον, ἡ δ' ἐπιστήμη τῷ τὸ καθόλου γνωρίζειν ἐστίν . . . οὐ μὴν ἄλλ' ἐκ τοῦ θεωρεῖν τοῦτο πολλάκις συμβαίνειν τὸ καθόλου ἂν θηρεύσαντες ἀπόδειξιν εἶχομεν· ἐκ γὰρ τῶν καθ' ἕκαστα πλειόνων τὸ καθόλου δῆλον.⁶³ Aristoxenus' depiction of melody in the context of harmonic science depends on this concept of the universal. It is through the listener's repeated experience of music that he can accumulate sufficient evidence to understand the essence of what it is to be melodic. Therefore accurate sense perception is initially required to collect the accumulated data from which is drawn its separable essence. Rather than any particular instance of melody, this essence is a synthesis of all melody. As such, it is not subject to change and belongs to all types of melody regardless of musical trends or different performances, as Aristoxenus notes: ἐπεὶ γὰρ ἐν τοῖς αὐτοῖς φθόγοις ἀδιαφόροις οὔσι τὸ καθ' αὐτοὺς πολλάί τε καὶ παντοδαπαὶ μορφαὶ μελῶν γίνονται, δῆλον ὅτι παρὰ τὴν χρῆσιν τοῦτο γένοιτ' ἂν.⁶⁴

Accepting the way in which Aristoxenus' subject is eligible to be the object of theoretical examination is essential to understanding his developmental progress towards an axiomatic science. It is from this perspective that the aims of his treatise become clear.⁶⁵ Rather than present any cosmologically significant, mathematically balanced, or otherwise meaningful insights into music, or merely describe an incomprehensible collection of unrelated pitches, Aristoxenus seeks to organise into a coherent system that which we perceive when we hear a melody. He merely makes explicit the principles that are exemplified in our own experience of it which he claims are inherent in its

nature (32.10–12). His emphasis falls on the natural progression of melody and our immediate grasp of how it is organised.

Indeed it is clear that Aristoxenus' *Harmonics* employs the Aristotelian methods of the *Posterior Analytics* to present the subject of melody in three parts. The emphasis on demonstration and causes, and the insistence on subject limitation or "same domain" from this text is combined with the concept of theoretical science from the *Metaphysics*. Introductory material and the principles are treated in the first two books of Aristoxenus' treatise, and the third book presents theorems about succession based on the information in the principles.

CONCLUSION

While—as will be discussed in Chapter Three—Aristoxenus' attempt to apply the Aristotelian axiomatic method to harmonic science is not entirely appropriate, he does succeed in achieving many of the ambitions dictated by his Aristotelian criteria. He separates harmonic science from other disciplines. He is systematic and (as far as the treatise survives) gives a complete description of melodic phenomena, he succeeds in defining the elements of the science, and in setting the programme of harmonics for the following generations.

In the absence of an existing systematic musical theory whose explanation is independent from other realms of science, Aristoxenus has to develop his methodology from very little material. Although there are flaws with Aristoxenus' theorems as demonstrable theorems, it is important not to forget what he does achieve with his descriptive analysis of musical space. He establishes an entirely new way of understanding melody through a dynamically conceived structure. As he says himself, "No account of these things with or without demonstration, has ever yet been given by anybody." (5.21–3). The account which Aristoxenus provides is not logically sound, but he sets a program for musicology, capable of much future development.

Chapter Three

The *Harmonics*

INTRODUCTION

The previous chapters have discussed earlier approaches to the subject of harmonics, both mathematical and empirical. Although he accepted some empirical theorists as his predecessors, Aristoxenus has drawn his methodology primarily from Aristotle. Accordingly, the present chapter examines in more detail the way in which he applies the Aristotelian criteria of scientific investigation to the pre-existing but ill-defined discipline which examines musical phenomena.

Firstly, the *Harmonics* as a whole will be examined and the way in which it organises the information necessary to the field of harmonics in order to create an independent science. To a certain extent, Aristoxenus' process of developing this science may be gleaned from the text itself, as the author attempts to define his subject and organise it into a coherent framework. Therefore the treatise's compositional process will be treated, and in particular the theoretical development which can be seen between Books I and II.

Secondly, we will look at the way in which the resulting treatise represents Aristotle's programme for a natural theoretical science. The *Harmonics* sets out, after some preliminary discussion, first the principles and axioms of the subject and then draws from them demonstrated propositions. However, it must be acknowledged that Aristoxenus' attempt to create an axiomatic science to describe musical structures is not entirely successful.

1. THE EXTANT TREATISE

The treatise by Aristoxenus known as the *Harmonics* or the *Harmonic Elements* has survived in the manuscript tradition in three incomplete books. The amount of duplicated and contradictory material between the first two

books has led almost all editors of the text to question its intended form. Indeed considerable evidence suggests that more than one work has been preserved under a single title and that the primary treatise consists of Books II and III of our text, while Book I is a preliminary work.

In addition, the slight discrepancy in the manuscripts about the name of the treatise indicates some uncertainty. While the title is generally given as Ἀριστοξένου ἁρμονικῶν στοιχείων α' β' γ', there are some variations on the specific title of the first book, creating some doubt as to whether it is the first book of the *Elements*, or a book preliminary to the *Elements*.¹ This latter possibility makes the second book of our treatise the first book of the *Elements*. It is supported by the evidence of Porphyry who, in his *Commentary on Ptolemy's Harmonics*, appears to grant the title of *Principles* (περὶ ἀρχῶν) to Book I of our treatise,² and *Harmonic Elements* (ἁρμονικῶν στοιχείων) to the second book.³

Various solutions have been proposed to the problems presented by the text as to how Aristoxenus' treatise is structured. Those of the most notable authors—Westphal, Ruelle and Laloy—are summarised in the introduction to the edition of Da Rios (1954) and more recently in Bélis' monograph *Aristoxène de Tarente et Aristote: Le traité d'harmonique* (1986). Macran's edition (1902) does not treat the issue in any detail. Da Rios⁴ examines the difficulties inherent in the text and the problems of the editions of Westphal and Ruelle which involve some complex re-arranging of material. In conclusion, she settles most reasonably for the status quo because of the limitations of the evidence.⁵ Bélis creates a careful argument for the unity of the work consisting of two sections, the *Principles* and the *Elements* each divided into two main sections.⁶ According to her, the work as a whole is based on Aristotle's scientific method and progresses from summary definitions to more precise analysis and concludes with demonstrative syllogism. In his recent exposition of Greek music and its theory, Mathiesen has set out his understanding of how the work is structured, and like Bélis, he distinguishes the first two books as *Principles* and *Elements*. He suggests that the works are quite separate from one another and that the former is a preliminary work on musical principles.⁷

In Chapter Two we outlined some similarities between Aristoxenus' approach to establishing a methodology for harmonic science and Aristotle's description of what a science should be, and in particular natural theoretical science. It is time to examine in detail how the extant treatise fits into this analysis of Aristotle's natural theoretical science, including subject limitation and a two-part structure of *Principles* and *Elements*.

Aristoxenus' clear ambition to create for harmonics an investigation based on first principles is in accordance with the description Aristotle gives

for science in the *Posterior Analytics* and *Physics*. However, it is not just in the general ambition of Aristoxenus' work that there are similarities to Aristotle's outlines but also in the use of a structure which progresses from Principles to Elements. One way of interpreting Aristoxenus' adoption in the *Harmonics* of such a structure is to see Book I containing the Principles and Books II and III the Elements. However, the possibility of this solution is undermined by the extensive overlap between the main sections of Books I and II. Another way of interpreting the structure of the work is to see the first book as a draft of, or a work preliminary to, the second. In this way, the Principles of harmonics are to be seen in what is now called Book II, and the Elements of harmonics set out in Book III.

The structure of the first two books is essentially the same. There are parallel sections covering the same material in Books I and II, from 19.23 and 44.21 respectively, and in general, the two books follow a similar plan throughout. Firstly, introductory sections to each book define the subject. Next, the programme for discussion sets out a list of the parts of the subject. After some methodological discussion, the parts of harmonics are discussed in turn, and finally each book concludes with a set of axioms on continuity and succession. This repetition is the first indication that Book II is a revision of Book I.

Despite the structural similarity, there are substantial differences between them and in three important ways the second book shows itself to be a revision of the first. The first is merely a matter of coherence. The second book is markedly better organised, contains fewer contradictions between sections, and in its introduction Aristoxenus carefully delineates the methodological principles which he will employ in his treatise before he defines the subject. The other two differences are conceptual: through the process of writing the first book Aristoxenus appears to clarify his definition of the subject in relation to other musical fields, and excludes superfluous material from the revision. Lastly, he refines the organisational framework within the subject itself through the development of the concept of *dynamis*. This idea is barely conceived in the first book but is intrinsic to the whole of Book II. Although both books break off at a similar point, the importance of *dynamis* to the discussion of Book III excludes the possibility of that book following directly on from Book I.

Aristoxenus' interpretation of axiomatic science also seems to accept the progression of Principles to Elements. In that case, the former title could be accepted for Book II of our edition, the latter title for Book III. The designation of the third book as Elements accords with what Aristoxenus anticipates near the end of Book I: τίνα μὲν οὖν τρόπον τό τε συνεχές καὶ τὸ ἐξῆς δεῖ ζητεῖν, σχεδὸν δῆλον ἐκ τῶν εἰρημένων· πῶς δὲ γίγνεται καὶ τί

μετὰ τί διάστημα τίθεται τε καὶ οὐ τίθεται, ἐν τοῖς στοιχείοις δειχθήσεται.⁸ This interpretation of the text would make much of the first part of Book I redundant while the second half is revised to become the second half of Book II. The first part of Book II, which contains considerable methodological discussion, then functions as an extended introductory section to the Principles whose body text begins at 44.29.

Admittedly, the assertion that Book II is a revision, and the first book redundant, is not free from difficulty. The most notable of these relates to the passage on the movement of the voice in Book I (8.13–15.13) which is excised on the present argument from the revised version of Book II. Many of the definitions and discussions from this passage are used by later scholars, such as Ptolemy, Nicomachus and Cleonides and Boethius. If Aristoxenus did revise the first book, and excluded this passage from his exposition of harmonic science, why then did almost all later theorists include it? It is possible that this passage independently formed the basis for a short preliminary study of harmonics or for a more acoustically-oriented work which could have treated the principles of musical sound, including the movement of the voice and the initial definitions of note, interval and *systema*.⁹ Even though the passage cited by Porphyry as the *Principles* (rather than the *Elements*) came from this discussion of the movement of the voice, this title might just be Porphyry's name for a preliminary work on the nature of musical sound. Certainly, other Aristoxenian titles cited by Porphyry appear to reflect the subject matter of the passage quoted rather than a complete work, for example Περὶ τοῦ πρώτου χρόνου (78.21) and Περὶ τόνων (78.17).

It is the internal evidence of the harmonic treatise which most strongly suggests that the second book is a revision of the first. The refining of the topic, the superior organisation, the omission of superfluous material and the inclusion of the idea of *dynamis* in the second book all indicate a process of revision. Admittedly, some of the other evidence does not necessarily support this point of view and it remains to be examined whether this evidence overrides that of the text itself. The putative revision of Book I is not just a matter of determining the original state of the *Harmonics*, for it may illuminate other aspects of Aristoxenus' musical theory. If it is to be accepted, it implies that his technique was primarily concerned with order and arrangement, with pruning away superfluous material from a discussion, with only including the essential elements of a subject. His other writings confirm this approach to scientific investigation, and it appears that Aristoxenus aimed to establish strictly divided areas for the examination of each subject.

The relationship between the two books is therefore also important in the context of Aristoxenus' other works. Much of Aristoxenus' innovation lies

in the categorisation of musical enquiry and involves a divisive rather than unifying perspective. The author aims to delineate boundaries around each of the subjects within musical enquiry, and with these divisions he establishes the science of musicology in the form with which we are most familiar today, with subjects such as organology, harmonics, rhythemics and acoustics—each part of a musician's knowledge, indispensable, but insufficient on their own—now dealt with in separate studies.

This is apparent in, or at least suggested by, the remaining material of the *Harmonics*, and is confirmed in the evidence surviving from his other works, which will be examined in the second part of this study. Whether the *Harmonics* is to be called Principles or Elements, the evidence seems to indicate that Book I of our treatise was revised and extended into Books II and III to form a single, relatively coherent work. In the remaining sections of this chapter the significance of excluding a substantial section (on the movement of the voice) from the harmonic treatise will be considered, as well as Aristoxenus' motives and methods for revising his initial exposition of the subject.

2. DEFINING THE SUBJECT OF THE *HARMONICS*

The first issue to be treated in Aristoxenus' exposition is, naturally, the definition of the subject. Aristoxenus is eager to separate that which belongs to his science from that which does not. From the very beginning, he tries to define the limitations of his subject and he emphasises that harmonics is only one part of the musician's skill. The opening of the first book states this immediately: τῆς περὶ μέλους ἐπιστήμης πολυμεροῦς οὐσῆς καὶ διηρημένης εἰς πλείους ἰδέας μίαν τινὰ αὐτῶν ὑπολαβεῖν δεῖ τὴν ἀρμονικὴν καλουμένην εἶναι πραγματεῖαν.¹⁰ This is to take the term *melos* in its broadest sense, which includes all things concerned with song, such as melody, rhythm and poetry, not mentioned here.¹¹

The author emphasises the nature of melody proper to music (4.9–13) and the orderliness of the putting together of melody (5.23–25), a matter which he says is overlooked by other theorists. His ambition is to systematise the science of harmonics and thereby to demonstrate how this order manifests itself in melody. This is attempted in two ways: firstly, the limitations of the subject are marked out and it is distinguished from other disciplines; secondly, Aristoxenus conceives a structure and a vocabulary with which to describe the order inherent in the nature of *melos*, as expressed in its patterns of movement within musical space. In the realisation of these objectives, the second book of Aristoxenus' treatise is considerably more successful than the first, particularly since the means to the second objective (treated in the following section) is established only with the definition of the concept of *dynamis*.

The description of harmonics in the second book, as the science which deals with all melody (περὶ μέλους παντός 32.10–11), indicates that Aristoxenus has refined his definition of harmonics, and is now using *melos* in a more restricted sense. Rather than being one of several sciences concerned with *melos*, harmonics is now practically synonymous with its study, and is one of several sciences in the field of music. The author is more specific here about which disciplines can be included in the broader range of musical sciences (32.9). At the same time as Aristoxenus defines the limits of harmonic science, he establishes a conception of musical art as a whole within which several sciences contribute to the musician's skill: πολλὰ γὰρ δὴ καὶ ἕτερα ὑπάρχει [ἡ], καθάπερ αἰεὶ λέγεται, τῷ μουσικῷ μέρος γὰρ ἔστιν ἡ ἁρμονικὴ πραγματεία τῆς τοῦ μουσικοῦ ἕξεως, καθάπερ ἡ τε ῥυθμικὴ καὶ ἡ μετρικὴ καὶ ἡ ὀργανικὴ.¹²

Having set out the limitations of harmonics in Book II, Aristoxenus sets up an initial framework, using an organising technique similar to the one which he has employed to define his subject, one which he continues to use throughout his work. In the same way as he divides musical science into several disciplines, one of which is harmonics, he distinguishes several parts within harmonics itself, and these parts are to be individually examined. The same language recurs several times in the treatise as Aristoxenus proposes to enumerate “how many and what kind of” (πόσα τ’ ἐστὶ καὶ ποῖ’ ἄττα) parts make up a particular element.¹³ In Book I this is used in relation to the science as a whole (νῦν ἔσται εὐσύνοπτον διεξιόντων ἡμῶν τὰ μέρη τῆς πραγματείας ὅσα ἐστὶ καὶ ἥντινα ἕκαστον αὐτῶν δύναμιν ἔχει¹⁴), and in relation to a possible future discussion on a more inclusive science which would include studies at a higher level than harmonics.¹⁵ It is also used on a smaller scale in Book II, twice in relation to *systemata*, (6.4–5 and 36.16), and once with reference to modulation (38.14–15). In the third book, Aristoxenus claims that he has completed his description of a group of *systemata* in this way (65.19–20).

So, the definition of the science of harmonics is the first task of Aristoxenus in each book. The first book presents harmonics as only one of the subjects which concerns melody, and not one which extends as far as composition. In the second version, the actual definition is delayed until after some preliminary remarks, and here it is adjusted slightly in order that the subject encompasses everything to do with melody.

3. DYNAMIS

Having defined his subject, Aristoxenus needs to establish a structure and language with which to describe melody. Rejecting the Pythagorean mathematical

agenda on the basis of maintaining subject limitation, Aristoxenus attempts to structure his laws of harmonics around empirically-obtained evidence by extending the geometrically-conceived methods of the *harmonikoi*.

In fact, one of Aristoxenus' main problems, having excluded the expression of intervals in numerical ratios, is finding a way to give coherence to his argument and structure to his musical concepts.¹⁶ Without the organising criterion of numerical ratios, he relies on the concept of musical structure as it is understood by perception. His first attempt at a solution produces the preliminary ideas of continuity and succession (συνέχεια and ἐξῆς, 27.15) which develop in Book II into the more solid construction of *dynamis*. Both of these solutions tend to side step the dilemmas of mathematical impossibilities presented by the Pythagoreans rather than to solve them. Aristoxenus does use numbers to delineate the size of intervals in musical structure, and obviously he uses basic arithmetic to construct his tetrachords, but his description complements the information obtained through mathematical calculation, rather than replacing it.

The role which the notes play within the harmonic structure is more significant in Aristoxenus' science than the mathematical definition of precise intervals. Therefore his division of musical pitch space is flexible in a way that Pythagorean calculations cannot be. In the latter, the ratios of tetrachordal divisions have no margin for error, but for Aristoxenus a geometrically conceived perception of musical space allows a note to be in any position within a certain range.

Thus, in any genus, the *lichanos*, for example, can be tuned at any one of an infinite number of pitches within the range of a tone, but because of the context of the scale, it can only be heard as *lichanos*. In a diatonic scale, it may be pitched anywhere from a tone to a tone and a quarter below *mese*, but when its pitch moves further from *mese* than this, the genus is perceived to be the chromatic or enharmonic. The resulting "compressed" set of notes, the *pyknon*, becomes the defining element of the chromatic and enharmonic genera. In his discussion of this, Aristoxenus acknowledges that although the *pyknon* can be defined as occurring when the two smaller intervals at the bottom of the tetrachord are smaller than the remaining interval, or as the defining feature of the chromatic or enharmonic tetrachord, a true description of its nature must incorporate a flexibility about its size and a specification as to how it is heard: δῆλον δ' ὅτι οὐδὲν τούτων ἐστὶ πρὸς τὴν τῆς αἰσθήσεως φαντασίαν· ἐκείνη μὲν γὰρ εἰς ὁμοιότητα ἐνός τινος εἶδους βλέπουσα τὸ τε χρῶμα λέγει καὶ τὴν ἀρμονίαν, ἀλλ' οὐκ εἰς ἐνός τινος διαστήματος μέγεθος· λέγω δὲ πυκνοῦ μὲν εἶδος τιθεῖσα ἕως ἂν τὰ δύο διαστήματα τοῦ ἐνός ἐλάττω τόπον κατέχη ἐμφαίνεται γὰρ ἐν πᾶσι

τοῖς πυκνοῖς πυκνοῦ τινος φωνῇ καὶ περ ἀνίσων αὐτῶν ὄντων.¹⁷ It is the heard character of the group of notes that defines the *pyknon*, as much as the maximum size of one and a quarter tones. The equivalent defining ratio would be irrational, and impossible, for the Pythagoreans.

Consequently, the measurements of an interval or set of intervals can change, and yet still be heard as performing the same functions, and heard as the “same.” Similarly, Aristoxenus explains, two intervals of the same size can be heard to perform two different functions, and therefore be heard as “different.” The example which he provides (47.25–48.4) is that of the fifth, such as the interval from *nete* to *mese*, from *paranete* to *lichanos*, from *trite* to *parhypate*, and from *paramese* to *hypate*, which may have different functions in the scale depending on their position in the structure. The interval *nete* to *mese* involves two fixed notes which assume another fixed note (*paramese*) between them, a tone above *mese* and a fourth between *paramese* and *nete* itself infixed with two moveable notes. On the other hand, the notes *paranete* and *lichanos*, likewise a fifth apart, are the upper moveable notes of their respective tetrachords, and have a different function in the scale, and so on.

In Aristoxenus’ mind, therefore, the perception of a structure is more important than its measurement. He stresses that mathematical representation not only does not illuminate musical structures but that it even obscures the understanding gained by perception. It is therefore surprising that he insists on setting out detailed analyses of the structures of six forms of the tetrachord in rigorously quantitative terms. Furthermore, his descriptions of these structures attach exact sizes to almost imperceptibly different intervals such as third- and quarter-tones, which cannot be confirmed by the judgement of the ear; this seems to be at odds with his repeated emphasis on the exclusive authority of empirical evidence, and on the way in which melodic phenomena present themselves to perception. It is hard to resist the conclusion that he has overlooked some of the implications of his own methodology.

Despite these flaws, the concept of *dynamis* is an important development in musical theory. By incorporating the idea that each note within a *systema* is defined by its context and function, rather than by its precise pitch, it provides a framework for Aristoxenus’ empirical conception of the division of musical space. Because it designates notes by position rather than by interval measurement, it is a qualitative rather than quantitative assessment of musical space, and there is subsequently room in the Aristoxenian system for a flexibility about pitch which is absent from mathematical accounts.

It is important to note that the concept of *dynamis* does not appear fully conceived from the outset of treatise and indeed this is a decisive difference between the first two books of the *Harmonics*. This method of note definition

appears to develop from more general ideas of *synthesis*, *hexes*, *ephexes*, and *melos hermosmenon* which appear in the first book. Despite the lack of any precise statement about the dynamic nature of notes in Book I, there are several suggestions that Aristoxenus even at that stage conceived of music in this way.

A possible origin of the concept is evident in several passages in the Aristotelian corpus and in particular, Aristotle's discussion on the infinite division of space in *On Generation and Corruption* anticipates Aristoxenus' dynamic concept: τὸ δ' ἔστιν ὡς ὑπάρχει πάντη, ὅτι μία ὀπηοῦν ἐστὶ καὶ πᾶσαι ὡς ἐκάστη· πλείους δὲ μιᾶς οὐκ εἰσὶν (ἐφεξῆς γὰρ οὐκ εἰσὶν), ὥστ' οὐ πάντη.¹⁸ This example is comparable to Aristoxenus' description of an infinite number of possible positions of the *lichanos* in Book I: νοητέον γὰρ ἀπείρους τὸν ἀριθμὸν τὰς λιχανούς· οὗ γὰρ ἄν στήσης τὴν φωνὴν τοῦ ἀποδεδειγμένου λιχανῶ τόπου λιχανὸς ἔσται, διάκενον δ' οὐδὲν ἐστὶν τοῦ λιχανοειδοῦς τόπου οὐδὲ τοιοῦτον οἷον μὴ δέχεσθαι λιχανόν.¹⁹ Here we can witness a flexibility concerning the pitch of the note, even though the terminology specifically indicating function is avoided. The reference to a geometric concept of space is also evident in this description.

Other ideas preliminary to a developed conception of *dynamis* emphasise the existence of a natural and necessary order in melody. The terms continuity (συνέχεια) and succession (ἐξῆς),²⁰ first mentioned in the programme at 4.24, appear at the end of Book I (27.15). In order to clarify the meaning of these terms, Aristoxenus returns once again to the faults of his predecessors. For the second time, Aristoxenus criticises *katapyknosis* diagrams of the *harmonikoi*, because they imply that the voice can sing twenty-eight consecutive *dieses*, when it cannot even sing three. At this stage, although the impediment to which Aristoxenus refers is plainly structural rather than physical, he does not explicitly introduce the idea of *dynamis* to explain why the voice can only complete the interval of the fourth after two ascending *dieses*. Instead he only expresses the need to understand the nature of melody, and which interval is naturally placed after which.²¹

In the second book, the term *dynamis* is introduced at an early stage, though no explanation of its meaning is provided. Following on from his general statement of intention about principles and demonstration in the introduction to the second book, Aristoxenus explains how this process is to be applied to music through the dual process of perception and reason. This is the first statement concerning the role of *dynamis*, whose concept is adumbrated in the first book, but now is clearly and concisely declared: τῇ μὲν γὰρ ἀκοῇ κρίνομεν τὰ τῶν διαστημάτων μεγέθη, τῇ δὲ διανοίᾳ θεωροῦμεν τὰς τούτων δυνάμεις.²²

Between Books I and II the criteria for melodic coherence move from an emphasis on melody perceived as a whole (harmonically-attuned melody, or *melos hermosmenon*) to an emphasis on the role (*dynamis*) of each constituent part within that whole. This is exemplified in the difference between the definitions of note given in each book. That in Book I primarily states that a note is the incidence of a voice on a pitch, but almost as an afterthought adds the comment that a note is capable of becoming part of *melos hermosmenon* (15.18–21). In the second book, a discussion of the true nature of a note is anticipated in the programme as the author asks whether a note is either a pitch (as it is defined in Book I) or a function: τρίτον ἂν τι μέρος εἴη τῆς ὅλης πραγματείας τὸ περὶ τῶν φθόγγων εἰπεῖν ὅσοι τ' εἰσὶ καὶ τίνι γνωρίζονται καὶ πότερον τάσεις τινές εἰσιν, ὥσπερ οἱ πολλοὶ ὑπολαμβάνουσιν, ἢ δυνάμεις καὶ αὐτὸ τοῦτο τί ποτ' ἐστὶν ἡ δύναμις.²³ There are several points for comment. Firstly the building block of melody, the note, has been postponed to the third part of the science, after genera and intervals. There is not much point in discussing something as a function if it has no context in which to be a function. Moreover, the phrase ὥσπερ οἱ πολλοὶ ὑπολαμβάνουσιν in a treatise constantly indicating other people's incompetence, suggests that we should take the alternative view, and therefore we are to understand that notes are indeed functions. The solution to this question is not stated in Book II, although the discussion of notes which does occur in the Principles (47.9–50.17) makes it clear that the latter option is understood by Aristoxenus.

Thus, the concept of *dynamis* is an integral part of Aristoxenus' understanding of musical space even from the beginning of the treatise, despite the fact that it is not mentioned in the first book. Precursors to the specific expression of *dynamis* are present from the start through the concept of a natural form of melody and arrangement of *systemata*. In the second book this is clarified as the position of the note within a *systema*. It is possible that Aristoxenus intended to introduce *dynamis* before the end of Book I, but it is significant in the revision that he has included it from the outset. He has recognised it as integral to his whole concept of this division of harmonic space, and indispensable to the work.

4. ORGANISATION

Progressive conceptual development throughout the first book of the *Harmonics* eventually demands the total revision which we call Book II. Aristoxenus starts afresh in the second book with his methodology worked out in advance, and this is apparent in the considerably clearer organisation and expression of that book. Although there are certainly problems with

asserting that Book I is merely an earlier draft of Book II, rather than an intrinsic, albeit preliminary, part of the same work, the types of repetition and difference which occur between them indicate very strongly that the author's original thoughts have been fundamentally revised, and the text rewritten.²⁴ Considering the magnitude of Aristoxenus' achievement—that he has moved the ambition for harmonic science from a universal to a specialist perspective—it is not surprising that the pioneering treatise of this new science is not perfected in one draft.

The similarity between the main body of the text in Books I and II is the primary witness to the revision of the treatise, so we will deal with this first. From 19.18 in Book I and 44.21 in Book II, Aristoxenus follows the same plan. As the diagram below shows, he treats genera, intervals, notes and *systemata*, followed by axioms related to continuity and succession. Book I is terminated at this point while Book II progresses (assuming a few linking paragraphs) to the theorems of Book III. It is worth noting also that the order of subjects treated in both books is the same as the beginning of the programme set out for Book II.

1. Genera
 - 1a: There are three types of genus, diatonic, chromatic, and enharmonic (19.18/44.21).
2. Intervals
 - 2a: Some intervals are concordant, some discordant (20.1/44.29).
 - 2b: There are eight concords (21.19/45.5).
 - 2c: The tone is defined as a fifth minus fourth (21.20/46.1).
Book II: Fourth is also defined as $2\frac{1}{2}$ tones, cf. 3c (46.2).
 - 2d: Enumeration of melodic intervals (21.23/46.4)
3. Notes
 - 3a: The movement of notes is the source of difference between genera (21.32/46.20).²⁵
E.g. between *mese* and *hypate* (22.8/46.21).
 - 3b: Range of *lichanos* (22.29/46.33).
 - 3c: Range of *parhypate* (23.28/47.8).
Book I: Definition of size of fourth, cf. 2c (24.10).
Book II: Infinite range of notes and their dynamic relationships, cf. 4b (47.9–50.17).
4. *Systemata*²⁶
 - 4a: Definition of *pyknon* (24.12/50.18).
 - 4b: Shades of genera through sizes of *pyknon* and positions of *lichanos* and *parhypate* (24.15/50.22).

Book I: Infinite range of notes, cf. 3c (26.14).

Book II: Relative position and size of intervals within tetrachord (52.10).

4c: Definition of succession and continuity (27.15/52.33).

Book I: Comparison to letters (27.18) (A comparison to letters has appeared in Book II before the principles at 37.2).

4d: Axioms on continuity and succession (29.1/53.33)

Axiom I: The fourth note in a melodic sequence forms the consonant of a fourth with the first note, or the fifth note forms a fifth (29.1/54.2).

Book I: Six other axioms

Book II: Two other axioms

Unlike the parallel structures in the second halves of Books I and II, the first half of Book I contains significantly different material from that of the revision. However despite the differences, the opening sections of each book nevertheless perform the same introductory function. They both define the topic, set out the programme for discussion, and prepare the audience for the empirical approach Aristoxenus is to take in the Principles. As we have said, Book II is considerably better organised than its predecessor. There is more methodological discussion setting out a detailed approach to the subject in advance, thereby avoiding most of the contradictions and repetitions which occur in Book I. In addition, the second book maintains a focus on general principles of harmonics whereas the first book tends to refer heavily to specific examples.

The superior organisation in the introduction of Book II is apparent from the outset. While the programme of the second book presents a list of seven parts of harmonics to be treated, that of the first book contains around fifteen parts, not always clearly delineated, some of which are repeated. Both programmes anticipate a discussion of genera, intervals, notes, *systemata*, *tonoi* and modulation, and Book II includes one other topic, the study of composition (38.18), which is deliberately excluded from Book I (2.1–2). The full significance of this change of policy is unfortunately impossible to judge, since no Aristoxenian discussion of composition has survived.²⁷ In addition, Book I includes several topics omitted from the revised programme. Most significant of the omissions is the group of topics concerning the movement of the voice, but others include *melos hermosmenon* (well-attuned melody), mixtures of the genera, and regions of the voice.

Defence of the division of Book I at 19.18 into Introduction and Principles comes from Aristoxenus' own signpost. Admittedly, there is an

argument for ending the introduction at 8.4–5, and accepting the passage on the movement of the voice as part of the main text. At this point, the definition of the subject and the list of parts is complete and Aristoxenus notes that “these then are the parts of the science called harmonics” τὰ μὲν οὖν τῆς ὁρμονικῆς καλουμένης ἐπιστήμης μέρη ταῦτα. This seems to indicate the closing of one section and indeed the treatise begins to discuss the subject matter anticipated in the programme starting with the movement of the voice. However, at 18.5–7 Aristoxenus makes a second concluding statement indicating that he is progressing to a more advanced discussion: τούτων δ’ οὕτως ἀφωρισμένων τε καὶ προδιηρημένων περὶ μέλους ἂν εἴη ἡμῖν πειρατέον ὑποτυπῶσαι τί ποτ’ ἐστὶν ἡ φύσις αὐτοῦ.²⁸ The body text then begins, after some preliminary discussion of *melos hermosmenon*, with the discussion of the genera. This is also the first subject of the Principles in Book II (44.21) and the point of convergence between the two books indicates that Aristoxenus has seen this part of the text as a critical moment, where the body of the text to be preserved is separable from the introduction which needs total revision. The parallels and differences may be best appreciated through setting out the structure of the presentation of material with the contents of Books I and II together.

INTRODUCTION

Definition of Subject

Book I (1.20)

“Whatever is relevant to an understanding of *systemata* and *tonoi*.”

Book II (32.10)

“The science which deals with all melody.”

Programme

Book I (3.2)

movement of the voice (3.6): continuous and intervallic (3.9); relaxation, tension, height, depth and pitch (3.28); extension between high and low (4.1): intervals (4.4): *systemata* (4.5): melody (4.10): continuity and succession (4.24): genera (4.26): intervals (5.1): *systemata* (6.1): mixtures of genera (7.1): notes (7.8): regions of the voice (7.16): modulation (8.1)

Book II (34.31)

genera (35.1): intervals (35.28): notes (36.2): *systemata* (36.16): *tonoi* (37.10): modulation (38.9): melodic composition (38.18)

Preliminaries

Book I (8.13)

movement of the voice: continuous and intervallic (8.13); relaxation, tension, height, depth and pitch (10.12); extension between high and low (13.31); notes (15.15); intervals (15.23); *systemata* (15.33)

Book II (39.2)

methodological discussion: against notation theories (39.2); against instrumental theories (41.27)

PRINCIPLES

Body text

genera (19.23/44.21)

intervals (20.1/44.29)

notes (21.32/46.20)

systemata (24.12/50.18)

Axioms

continuity and succession (27.15/52.33)

ELEMENTS Book III

propositions demonstrated through axioms

further exposition of *systemata*

Furthermore, we note that the introduction of Book I is more concerned with specific examples than with general concepts of harmonic theory. It launches straight into a definition of harmonics, with no preliminary methodological discussion, describing it as whatever is relevant to an understanding of *systemata* and *tonoi* (1.20). In both books, before approaching the programme for the subject and the list of parts, Aristoxenus mentions some problems of previous work in the field. The *harmonikoi* are generally the target for his criticism but in the first book Aristoxenus is very specific about their faults, citing the problems of certain theorists. Maintaining a focus on the particulars, the initial criticism of his predecessors relates to specific issues, rather than general methodology: Aristoxenus complains that the *harmonikoi* do not cover a sufficiently broad scope of investigation as they only examine one genus and one magnitude (2.8–25). No mention is made of any errors in the group's conceptual understanding of the topic.

Throughout the discussion of parts in Book I, Aristoxenus continues to observe the misunderstandings of previous theorists in relation to specific points.²⁹ He names those who have attempted to elucidate the subject and how they have failed. Having criticised the unsystematic methods of the group in general (2.26), each aspect of harmonics is discussed in terms of how

it was mishandled or ignored by that school. Lasus and the followers of Epigonus, for instance, are mistaken in their concept of the note (3.20–23). Aristoxenus claims that the analysis of the *synthesis* of incomposite intervals has been left for the most part unconsidered by earlier theorists (5.5–9), although he does admit that the school of Eratocles has made an (inadequate) attempt at it. Similarly, on the matter of *systemata*, Eratocles is singled out for limited praise in his attempt at a description of *systemata* (5.9–10 and 6.13), but is criticised for enumerating the arrangements only of the octave, for not seeking the governing principles of melody, and for lacking demonstration.

Before Aristoxenus begins the main text at 19.18 there is an extended discussion of the movement of the voice which does not appear in the second book. This passage will be discussed in the following section, but for the moment it will suffice to say that the section defines the substance out of which melody is formed, and indirectly criticises acoustic methods of explaining this material.

Textual inconsistencies and general disorganisation in Book I indicate that Aristoxenus is not working to a pre-conceived plan. In the programme presented in the introduction, he mentions some topics more than once, having failed to cover every aspect of them: intervals are mentioned twice (at 4.4 and 5.1), as are *systemata* (4.5 and 6.1), and separate treatments of genera (4.26) and mixtures of genera (7.1) are anticipated. Some of the subjects in the introduction, such as the mixtures of genera, regions of the voice (7.16) and modulation (8.1) are not given their promised discussion. Similarly the discussion on the *systemata* appears to be incomplete, as it does not include the description of the greater and lesser perfect systems suggested at 6.4.

These anomalies seem to occur as Aristoxenus' conception of the imperatives of harmonic methodology are refined through the process of writing the first book of his treatise. His understanding of the subject and its boundaries develop to a point where some of his early conceptions are excluded. Admittedly, the first book as it survives is incomplete, accounting in part for the missing discussions. Yet it is possible that the remainder of the first book is not simply lost, rather that Aristoxenus abandoned it to write the revised version. Its preservation may then be accounted for by the fact that the author used the first version to structure the second.

From the very beginning of Book II Aristoxenus takes such a different approach to the subject from that of Book I that it cannot be attributed merely to its position later in the work. Besides, there is a clear indication that the beginning of the book contains the introduction to a separate work: βέλτιον ἴσως ἐστὶ τὸ προδιελθεῖν τὸν τρόπον τῆς πραγματείας τί ποτ' ἐστίν, ἵνα προγινώσκοντες ὥσπερ ὁδὸν ἢ βαδιστέον ῥάδιον

πορευόμεθα εἰδότες τε κατὰ τί μέρος ἔσμεν αὐτῆς καὶ μὴ λάθωμεν ἡμᾶς αὐτοὺς παρυπολαμβάνοντες τὸ πρᾶγμα.³⁰ It would make no sense to open a book with a discussion on the importance of setting out the subject in advance, if it were not the beginning of a treatise.

The anecdotal tone of this section compared with the rest of the work suggests a separation from the main text and, taken in the context of the material, confirms the preambulatory function of the passage. The praise of Aristotle and the criticism of Plato are in direct relation to the task of preparing an audience for what to expect in this treatment of the subject. Aristoxenus takes the opportunity to condemn Plato's technique and criticises previous audiences of his own lectures, claiming that they have misunderstood the nature of the subject and its limitations (31.15). These are general points, nothing like the criticism of Book I, which condemns the limitation of the study to the octave interval and enharmonic genus. Even though Aristoxenus does mention two theorists by name (Pythagoras of Zacynthos and Agenor of Mytilene, 37.1), these are not the detailed criticisms earlier aimed, for example, against Eratocles.

In this second introduction, Aristoxenus places harmonics in the context of general musical enquiry before defining it and dividing it into parts. The exposition of methodology in the opening of the second book delays the definition of the topic until 32.10–11 (a full two manuscript pages into the book) where Aristoxenus efficiently states the essential aspects of his approach to the topic. This is in three parts: he defines his subject, dismisses earlier approaches to it, and proposes his own methodological priorities. He states that harmonics is the “science which deals with all melody” (οὖσαν τὴν θεωρίαν περὶ μέλους παντός, 32.10–11), asserting the concept of a structure natural to melody and the importance of demonstration and perception. The ratio-based theories of some of his predecessors are summarily dismissed as irrelevant, and the unexplained, undemonstrated claims of empirical theorists condemned. His own approach, he concludes, will be to adopt principles and to demonstrate what follows from them. Rather than accumulating instances of Aristoxenus' understanding of melodic theory, which we see developing throughout Book I, the whole conceptual structure is presented in advance of the main discussion in little more than twenty lines. This is a more positive approach to the task: Aristoxenus sets out what his subject is and his own methodology for it, before attacking the work of predecessors or tackling the subject itself.

It is not until all this methodology has been proposed and justified in Book II that Aristoxenus names the parts of harmonic science. There are now no repetitions and each part is presented with a brief reason why it needs to

be discussed, and how it was misunderstood or ignored by previous theorists. It maintains a similar critical structure to that of the corresponding section of Book I but does not refer to such specific critical examples. The list includes genera, intervals, notes, *systemata*, *tonoi*, modulation and melodic composition. This last topic is excluded from the original programme.

After the list of the parts of harmonics, Aristoxenus reiterates the mental process essential to understanding melody (38.32–33) through perception and memory. He takes a position opposed to that of the Pythagoreans as he states that melody consists of a process of coming to be, and his understanding of music as a developing phenomenon rather than something static based on numerical relationships is reiterated.³¹ This second intermediary passage also contains general criticism of some empirical methodology, specifically of notation-based and instrumental-based theories. While in Book I this preliminary section focused on the need for perception to explain musical phenomena, rather than the acoustic theories of the Pythagoreans, in Book II the rebuttal of other methods remains in the empirical sphere.

Despite its superior organisation, the progress of Book II is still not entirely consistent and the surviving treatise does not contain all the promised discussions. The issues which are treated in both books are genera, intervals, notes, and (incompletely) *systemata* which includes the related subject of continuity and succession. Further discussion on the *tonoi*, modulation and melodic composition is completely absent because the treatise is cut off. The discussion of *systemata* continues throughout Book III when, in the middle of the enumeration of the forms of the fourth, the treatise ends. Nothing prevents us from supposing that Aristoxenus would move into the forms of the fifth, those of the octave, and perhaps other *systemata* such as the greater and lesser perfect systems. This could lead into the discussion of the *tonoi* which was the fifth subject of the seven promised in the introduction, followed by a treatment of modulation and finally of composition. This supposition is confirmed by the work of Cleonides which, while it overlooks much of the methodological achievements of Aristoxenus' treatise, summarises its essential points. The extensive discussion on *systemata*, presumably leading to an equally thorough exposition on *tonoi*, would reflect Aristoxenus' initial definition of the subject as ὅσα συντείνει πρὸς τὴν τῶν συστημάτων τε καὶ τόνων θεωρίαν "whatever is relevant to an understanding of *systemata* and *tonoi*" (1.20).

5. OMISSION OF SUPERFLUOUS MATERIAL

Along with the development of the theory of *dynamis* and the superior organisation of Book II, Aristoxenus makes a further refinement of his treatise

through the omission of superfluous material. Subjects which are not directly relevant to the discipline of harmonics are excised from Book II. The prime example of this is the passage on the movement of the voice occurring in the introductory section of Book I. The passage discusses the substance out of which melody is formed and emphasises the irrelevance of acoustic techniques to harmonic science. Its material appears nowhere in Book II.

These ten pages in Book I intervening between the end of the initial list of parts and the body text seem to have been deemed superfluous by Aristoxenus when he composes his second draft. The largest portion (8.13–15.13) describes the most basic nature of melodic sound and can conveniently be labelled with Aristoxenus' own term of *προδιηρημένα* "preliminary divisions." This is the material absent from the revised version. The discussion of the remainder of the passage, from 15.13–18.4, includes definitions of elemental musical features such as note, interval and *systema*, and is absorbed for the most part, but by no means entirely, into other discussions in Book II.

Three broad areas concerning musical sound are treated in this preliminary discussion, beginning with the movement of the voice. As with other matters in the introduction of Book I, Aristoxenus is specific in offering the theories to be rejected, rather than presenting an overall theoretical, methodological framework for his approach. As he distinguishes between intervallic and continuous movement of the voice (8.13–10.10), Aristoxenus rejects acoustic science in favour of aural perception: *ληπτέον δὲ ἐκάτερον τούτων κατὰ τὴν τῆς αἰσθήσεως φαντασίαν· πότερον μὲν γὰρ δυνατόν ἢ ἀδύνατον φωνὴν κινεῖσθαι καὶ πάλιν ἵστασθαι αὐτὴν ἐπὶ μιᾷ τάσεως ἑτέρας ἐστὶ σκέψεως καὶ πρὸς τὴν ἐνεστῶσαν πραγματείαν οὐκ ἀναγκαῖον τὸ [δὲ] κινῆσαι τούτων ἐκάτερον· ὁποτέρως γὰρ ἔχη, τὸ αὐτὸ ποιεῖ πρὸς γε τὸ χωρίσαι τὴν ἐμμελῆ κίνησιν τῆς φωνῆς ἀπὸ τῶν ἄλλων κινήσεων.*³² The second part (10.11–13.30) of the discussion on sound relates to the definitions of, and distinctions between, tension, relaxation, height, depth and pitch (*ἐπίτασις*, *ἀνεσις*, *ὀξύτης*, *βαρύτης*, *τάσις*). Acoustic theory is again rejected in favour of perception as Aristoxenus returns to specific contradictions between his own approach and those of physics-based theories.³³ The final section (13.33–15.13) of this acoustically-oriented treatment concerns the extension between high and low, and the question of whether there is a minimum and maximum extension for the voice, for instruments and for hearing. Aristoxenus states that the question of a theoretically indefinite extension towards ever greater intervals is again the subject of another enquiry.

These three issues, the movement of the voice, the definition of five terms, and the extension between high and low have covered seven pages (8.13–15.13), in which Aristoxenus seems particularly concerned to deny the relevance of theories about the physical basis of sound, and to assert that harmonics science must be grounded in the representations of perception. Aristoxenus mentions specific acoustic issues about the nature of vocal movement such as the co-ordination between changes in speed of motion and changes in pitch and thereby demonstrates his familiarity with the debates concerning acoustics. There is a possible reference to an acoustic work of Aristoxenus himself as he leaves the topic aside saying that it has been better treated elsewhere (12.32–33). But these parts of the discussion are best conceived as methodological preliminaries, designed to establish that acoustic theories can provide no criteria to explain the nature of harmonically-attuned melody. Perhaps for the revised edition Aristoxenus has heeded his own repeated advice about the irrelevance of the theories on which he comments here for, having asserted his belief in perception, he spends very little time in the second book justifying the contradictions of his theory against physical theorists.

After the initial discussion on the movement of the voice Aristoxenus moves on to the definition of the parts of harmonics such as notes (15.15), intervals (15.21), and *systemata* (15.33). The definition of the note in this first book effectively summarises the point of the passage from 8.13–15.13 that, regardless of its acoustic explanation, a note is the perceived incidence of the voice on one pitch. It does not include the association of function which distinguishes it from its introduction in the second book (36.6–12).

In Book II, Aristoxenus concisely dismisses the need to discuss mathematical techniques in a more abstract discussion of methodology which occurs before the list of parts: καὶ τούτων ἀποδείξεις πειρώμεθα λέγειν ὁμολογουμένας τοῖς φαινομένοις, οὐ καθάπερ οἱ ἔμπροσθεν, οἱ μὲν ἄλλοτριολογοῦντες καὶ τὴν μὲν αἴσθησιν ἐκκλίνοντες ὥς οὔσαν οὐκ ἀκριβῆ, νοητὰς δὲ κατασκευάζοντες αἰτίας καὶ φάσκοντες λόγους τέ τινας ἀριθμῶν εἶναι καὶ τάχῃ πρὸς ἄλληλα ἐν οἷς τό τε ὅξυ καὶ τὸ βαρὺ γίγνεται, πάντων ἄλλοτριωτάτους λόγους λέγοντες καὶ ἐναντιωτάτους τοῖς φαινομένοις.³⁴ The rejection of Pythagorean methods in such a succinct manner is remarkable compared with the extended discussion on the movement of the voice in Book I and its accompanying comments on the irrelevance of acoustic theories. With the greater defining and refining of his subject, Aristoxenus has deemed this discussion extraneous and unnecessary.

Instead of this acoustic discussion, in Book II between the definition and programme and the body text, Aristoxenus condemns at length harmonic methods based on notation (39.4 ff.) and on instruments (41.24 ff.). It is interesting that Aristoxenus has excluded his rebuttal of acoustic theories yet included discussion on these two methods. However, unlike acoustics, these methods are shown to be false in any context, not just irrelevant to harmonic science. Furthermore the importance of disproving them reflects the fact that their foundation, like that of harmonics, rests on empirical methods. This positions them closer to harmonics than the abstract theories of the mathematicians, and accounts for the need to disprove them while the ratio-based theories are brushed aside quickly.

We have seen the effect of refining the topic in the omission from Book II of the material on the movement of the voice. Acoustic science and ratio-based theories are outside the terms of reference for Aristoxenus' science because perception must take precedence over abstract analysis. He does not argue against acoustic theories *per se*; he merely states their irrelevance to his study. Similarly an historical aspect is introduced in the first book when the diatonic is defined as the oldest genus (19.18), and then the first and second ancient styles (23.9–10) are mentioned. Such historical comments are entirely omitted from the second book.

The sociologically-oriented subject of *ethos* has a more ambiguous position. In the first draft, Aristoxenus anticipates a discussion on the regions of the voice, and how the *systemata* are placed in particular *topoi*.³⁵ The author suggests that differences of *tessitura* will alter a melody radically, even if its intervallic structure remains the same. He does not identify the kinds of change that shifts in *tessitura* will introduce, but there is some indication in later Aristoxenian sources that they were associated with changes in the melody's *ethos*, whether or not that term is to be understood in a strictly 'ethical' sense.³⁶ Yet the expected discussion of the ethical or aesthetic effect of different *topoi* appears neither in the body of Book I, nor in the programme or principles of Book II. From this one could assume that Aristoxenus, as he does with historical and acoustic aspects, applies more rigorous limitations on the subject of harmonics and omits the subject from his revision. In the introduction to Book II, as he tries to clarify what belongs to his subject, Aristoxenus criticises how previous audiences have distorted his message and, though his precise meaning is obscure, he clearly plays down the connection between music and ethical improvement.³⁷ However, he associates the classification of types of melodic *ethos* with the study of composition (31.24) and it may have been included in one of the missing sections on *tonoi*, modulation or composition. If, as seems likely, Aristoxenus considers that there is a connection

between *tessitura* and ethos this would confirm its place in the discipline. Furthermore, the work of Cleonides, summarising Aristoxenus' treatise, does mention ethos in the context of modulation.³⁸ This is far from conclusive, and in Ps.-Plutarch (1142f) the discussion of the limits of harmonics, probably also of Aristoxenian origin, specifically excludes this area.

In general Aristoxenus removes extraneous material from his revised treatise. While the inclusion of material related to ethos is uncertain, it seems that it may have been relevant to the composition of melody, which is the final object of harmonic science. In contrast, comments on historical aspects have been excluded from the revised edition and acoustic theories are summarily dismissed, although neither are rejected *per se*. It is clear that the purpose of Aristoxenus' Book II is limited to a study of melody from an empirical perspective, which is separable from theories of historical development or physical cause. This greater delimitation, on the other hand, necessitates much more direct refutation of similarly empirical theories, and so two theories which may have been considered relevant to Aristoxenus' approach (precisely because of their empirical foundation) are given extended refutations in the second book.

6. AUDIENCE RESPONSE

A further witness to the revision of Aristoxenus' treatise comes from the evidence of the audience's reaction to the work. References in Book II to the queries from students on the harmonic concepts of Book I indicate some of the problems which occasioned the rewrite.³⁹ While Book I has references to Aristoxenus' previous work on related subjects (on the *harmonikoi* and acoustics), the second book refers to his own previous works on harmonics. In addition, Book II specifically refers to public lectures (31.23) and how the audience needs further explanation on subjects which appeared in Book I. It is illuminating to compare the criticism of predecessors, which appears throughout the treatise, to the confusion of his audience, which makes its first appearance in the second book.

We can accept that Aristoxenus' audience already has some familiarity with the science of harmonics since he uses highly technical musical terminology, such as genus, *harmonia* etc. from the beginning of the treatise. However, it is clear that his approach to the subject is new, from the evidence that his pupils misunderstood or queried the concepts raised in the first book. It is indeed possible that the need to clarify topics in Book I misunderstood by the audience has motivated its revision, and it is significant that the confusion for the most part relates to the areas in which Aristoxenus has developed his most innovative ideas on melodic organisation. Clarification on concepts related to continuity and succession and the functional division of

harmonic space may have prompted the further development of the concept of *dynamis*, or at least its expression.

Much can be learned from the three points in Book II where Aristoxenus attempts to correct the audience's misunderstanding of his earlier lectures, and from the further four in Book III. All those in Book II refer to the concept of *dynamis*, or how succession and continuity are relevant to melodic structure. In the first, a question is asked about whether notes are to be defined as pitches or as functions (36.10). A second point relates to the smallest melodic intervals (46.9–19), as Aristoxenus' previous audience has misunderstood how they operate in the context of *systemata*. He explains that three third-tones cannot be used successively simply because a tone can be divided into three parts. Thirdly, Aristoxenus notes that some of his audience have been confused by the concept of a note remaining the "same" note although its position may change (47.9–10).

As the discussion on *systemata* continues into Book III, Aristoxenus raises a further point of audience confusion: ἤδη δέ τις ἠπόρησε τῶν ἀκουόντων περὶ τοῦ ἐξῆς· πρῶτον μὲν καθόλου τί ποτ' ἐστὶ τὸ ἐξῆς, ἔπειτα πότερον κατὰ ἓνα μόνον γίγνεται τρόπον ἢ κατὰ πλείους, τρίτον δ' εἰ ἴσως ἀμφοτέρω ταύτ' ἐστὶν ἐξῆς τὰ τε συνημμένα καὶ τὰ διεξευγμένα.⁴⁰ This confirms that Aristoxenus has already presented lectures (perhaps those referred to at 31.24) on harmonics or melody, which included sections on succession.

Nor is this the only such example. At 62.19 Aristoxenus restates his proposition concerning the number of incomposite magnitudes in the fourth and fifth.⁴¹ At 68.13 there is an exposition of how *dynamis* is applied in the context of continuity. This prompts an extended departure from the theorem-explanation format of Book III as Aristoxenus returns to the subject of notes being situated in one of an infinite number of positions within a certain range. This has to be clarified because Aristoxenus has referred to standard forms of the genera in his theorems. He has used representative intervals throughout the book, for example using the ditone to symbolise the highest interval of the fourth in the chromatic or enharmonic genus, the other two intervals of which would make up a *pyknon*. Since this refers to an issue within the same book it is possible that the processes of writing and teaching occurred simultaneously, and affected one another. Another reaction to the audience concerns the intervals of the genera and why the diatonic genus can be composed from two incomposite magnitudes, but not the chromatic or enharmonic (73.32–74.1).

The revision of the treatise is further confirmed by the evidence for the audience's reaction to Aristoxenus' theory. It is evident that Aristoxenus

develops the most innovative idea of his treatise, *dynamis*, through the process of composing Books I and II. The evidence for the confused response of his listeners offers a possible reason for this development.

7. THE ARISTOTELIAN SCIENCE OF HARMONICS

This final section on the *Harmonics* concerns the way in which the structure and methodology of the treatise conforms to the Aristotelian description of a natural theoretical science. Aristotle's science has as its final purpose the axiomatic expression of the knowledge contained in that science. Similarly, Aristoxenus aims at an axiomatic expression of harmonics and, in accordance with Aristotle's programme, he treats some preliminary matters before setting out the principles of his science. This section is concluded with a set of axioms from which are drawn the theorems of Book III.

The success of this axiomatic science is mixed. The propriety of applying such a method to music rapidly becomes doubtful when Aristoxenus attempts to set out a collection of theorems about succession, though these problems do not entirely undermine the work's substantial achievements.

7a. Preliminary Matters

In the extensive introductory sections of the *Harmonics*, Aristoxenus not only discusses methodology but also outlines the anticipated discussion of what he calls the parts of harmonics. However, much of the content of these preliminary discussions seems superfluous to the Aristotelian program of stating fundamental principles and drawing conclusions from them.⁴² Even taking into account the imbalance caused by the partial preservation of the treatise, Aristoxenus seems to spend a long time on preliminaries before moving on to principles and theorems.

The extensive treatment of the definition of musical phenomena must be attributed to a need to illuminate the natural and essential cause of melody, how it is organised and how it is to be understood. Aristoxenus has drawn from several Aristotelian sources in his interpretation of demonstrative knowledge, particularly from discussions of the four types of cause: essential, formal, efficient and final.⁴³ The first two are important in what remains of the *Harmonics*, in the forms 'of what does melody consist?' and 'how is it arranged?'⁴⁴ In Aristotle's exposition of matter in the *Physics*, necessity in nature is explained as the substance of an object.⁴⁵ Matter is necessary for an object to exist, but it is insufficient on its own to cause its existence. In the context of harmonic science, an introductory section on the material of melody and the method by which it can be explained is essential before the

principles are stated. Only then can a discussion of form be incorporated into the discussion of matter in order that the essence of melody is not understood merely to consist of an incomprehensible collection of sounds. This preliminary process is particularly important to Aristoxenus because he sees himself as the first person to deal with the subject correctly.

As we have noted with regard to the description of the substance of melody, there are significant differences between Books I and II of the *Harmonics*. In the first book Aristoxenus' presentation is as fundamental as possible. He describes the voice itself, marking the difference of its movement between speech and song. He also defines the elementary concepts of relaxation, tension, depth, height and pitch.⁴⁶ Throughout this introductory section emphasis is placed on how the musical phenomena are perceived, and discussion is deliberately avoided about the acoustic explanation of the sound itself. Aristoxenus is clearly aware of the theories based on acoustic enquiry but states that they belong to another study (9.4–6). The criterion of perception used for the final definition of a musical note as φωνῆς πτώσις ἐπὶ μίαν τάσιν⁴⁷ is supplemented by the qualification τότε γὰρ φαίνεται φθόγγος εἶναι τοιοῦτος οἷος εἰς μέλος τάττεσθαι ἡρμοσμένον <ὅταν ἡ φωνὴ φανῇ> ἐστάναι ἐπὶ μιᾷς τάσεως.⁴⁸ It is from here that Aristoxenus builds up his description of melody in a similar way to a geometrical depiction of space involving a point, line and plane. Starting from the note, Aristoxenus moves on to intervals (15.23) as the combination of two notes of different pitches, and then defines a *systema* as the putting together of more than one interval. Aristoxenus acknowledges the limited scope of these definitions, but states that he merely aims to give the audience an approximate idea of the phenomena at this stage (16.2–16). The introduction closes with a few points about natural differences between *systemata*.

The second book, by contrast, does not spend nearly so much time on the material out of which melody is shaped. There is an intimation that the matter will be discussed, but it does not appear in the text which remains to us. A much greater part of the introduction is concerned with methodology (both that rejected and accepted by the author) and with how music is to be understood. In his definition of notes Aristoxenus states that they must be recognised (36.9), not merely perceived. This, and the emphasis on memory (38.32–33), establishes the importance of the note as part of a temporal system. It is analogous to the claim that a combination of perception and reason is required for a full understanding of melody (33.7–9). Further, a functional analysis of two elements of melody allows for the nature of music ὅτι ἡ τῆς μουσικῆς ξύνεσις ἅμα μένοντός τινος καὶ κινουμένου ἐστί.⁴⁹ That is, it gives us the capacity to place in context not

only an example of music in the context of all possible harmonious music, but on a smaller level, to place in context the fixed notes and the movable notes of the tetrachord (despite the fact that the pitches of the latter are variable) within the scale system.

The extensive discussion concerning the movement of the voice is therefore omitted in Book II and the note no longer functions on its own as the building block of melody. There is now a much more developed sense that melody's understanding must integrate the measurable elements of musical examples with the perceptible flexibility of structural musical comprehension. Importantly, the treatment of the subject of notes in the second book includes the notion of *dynamis*. A sense of necessity predominates the way in which Aristoxenus perceives melody and the concept of the natural placement of notes within it (32.15). In this second version of the introduction it is established that the building block of melody may be the note (φθόγγος), but only the note *as part of a naturally ordained melodic structure*. Correspondingly, Aristoxenus' focus is no longer on the movement of the voice as such, but on the role of each note within the patterns formed by its dynamically conditioned movements. Furthermore, the discussion of genera and intervals must precede the discussion of notes in the second exposition, because notes can only comprise the elements of melody in the context of the correct musical form.

As in other cases, Aristoxenus has followed his teacher in the theory of science, but not in the example. Among the passages in which he uses music as an example, Aristotle has suggested that the *diesis* is the principle (ἀρχή) of melody, being the "one," the unit of measurement for all other intervals: καὶ ὥσπερ ἐν τοῖς ἄλλοις ἡ ἀρχὴ ἀπλοῦν, τοῦτο δ' οὐ ταῦτό πανταχοῦ, ἀλλ' ἐν βάρει μὲν μνά, ἐν δὲ μέλει δίεσις, ἄλλο δ' ἐν ἄλλῳ.⁵⁰ Rather than Aristotle's *diesis*,⁵¹ Aristoxenus' primary cause appears to be the single note in a certain context. Aristoxenus' measure is in practice the tone, because it is the perceptible difference between a fourth and fifth.⁵² The measure for Aristoxenus is not his primary cause, although it is fundamental to his further descriptions of intervals.

In conclusion, Aristoxenus' attempt to establish the essence of melody precedes his statement of its principles. In Book I, it involves an extended discussion on the movement of the voice concluding with the description of the perceptible resting of the voice on a series of pitches, arranged according to nature. The revised version of Book II has greater emphasis on the method appropriate to understanding harmonics and a more concise exposition of the seven subjects to be covered by the science, four of which are encountered in the subsequent principles. In this book also, there is a short methodological discussion reminding us of the importance of achieving principles from which

demonstration can follow, which is absent from Book I. However, both versions proceed from these preliminaries to fundamentally similar expositions of principles concerning the form which this arrangement of musical space takes.

7b. First Principles and Axioms

The introductory discussion of the *Harmonics* ends in Book I at 18.5–7: τούτων δ' οὕτως ἀφωρισμένων τε καὶ προδιηρημένων περὶ μέλους ἂν εἴη ἡμῖν πειρατέον ὑποτυπῶσαι τί ποτ' ἐστὶν ἡ φύσις αὐτοῦ.⁵³ This is followed by a passage indicating that the subsequent discussion will be focused on the search for the organising structures of harmonically attuned melody, such as the combination of intervals and the arrangement of notes. In Book II there is a parallel break from the preliminary discussion at 43.25–30: ἃ μὲν οὖν προδιέλθοι τις ἂν περὶ τῆς ἀρμονικῆς καλουμένης πραγματείας σχεδὸν ἐστὶ ταῦτα· μέλλοντας δ' ἐπιχειρεῖν τῇ περὶ τὰ στοιχεῖα πραγματεία δεῖ προδιανοηθῆναι τὰ τοιαῦτα.⁵⁴ Similarly, there follows a methodological discussion of the conditions required for the exposition of elements. It clarifies the priority of principles—which do not need demonstration—from which theorems can be deduced.

In both expositions, these milestone sentences are followed by sections which could be called the principles of harmonics. As we have seen above, this section in each book covers identical parts of harmonics in the same order: genera, intervals, notes and *systemata*, before diverging on axioms related to succession. Despite some differences, there is significant overlap between the seven axioms on succession in Book I and the three in Book II. The Principles of harmonics, then, are presented as the most basic structures of melody and a description of their arrangement. The axioms presented at the end of each book attempt to provide rules for melodic succession to which the theorems following may refer. However, as we shall discuss below, they are insufficient without the preceding description of the scale system based on the tetrachord and none of the axioms presented at the end of each book is the direct proof of any of the theorems which follow in Book III. Nevertheless, if we include the whole section of the principles (from 43.25) as the material to which the theorems can refer, then we can say that Aristoxenus has by the end of Book II described the basic *systema* of which melody consists, that is the tetrachord in all its shades, the typical instance of which is between *mese* and *hypate*.⁵⁵

Therefore, following his exposition of the elements of melody, Aristoxenus attempts to codify the laws of melodically valid musical structures which are used as proofs for the theorems in the following book. In Book I there are seven axiomatic statements relating to succession, in Book II there

are two statements on succession and one on the perception of concordant intervals. In both books (or editions, if the present argument is accepted) there is a strong emphasis on the natural order of melody, and the version of Book I is prefaced with the instruction: ἀλλὰ πρὸς τὴν τῆς μελωδίας φύσιν πειρατέον βλέπειν κατανοεῖν τε προθυμούμενον τί μετὰ τί πέφυκεν ἡ φωνὴ διάστημα τιθέναι κατὰ μέλος.⁵⁶ This particular instruction, as we shall see, is actually more applicable to theorems (v)—(xxviii) of Book III, while the revised directive of Book II merely states that κατὰ τὴν τοῦ μέλους φύσιν ζητητέον τὸ ἐξῆς.⁵⁷ The discussion of succession in the first book is based on examples, referring often to the names of notes, while in the revision the description is considerably more abstract and—like the first four theorems of Book III—more general.

At the beginning of this section in Book II, Aristoxenus notes: ἔχόμενον δ' ἂν εἴη τὸ ἀφορίσαι τὸ πρῶτον καὶ ἀναγκαιότατον τῶν συντεινόντων πρὸς τὰς ἐμμελεῖς συνθέσεις τῶν διαστημάτων.⁵⁸ While this aptly reflects the gnomic ambition of these rules, rather than the specific instances of interval progression emphasised in Book III, the three axioms are insufficiently comprehensive and Aristoxenus, as we shall see, is well aware of this.

Aristoxenus' ambition to construct an axiomatic science is seen in the language he uses in the Principles. Often a singular third person imperative form is used to introduce an asserted statement. In the introduction to Book II, Aristoxenus has even mimicked this tone when comparing harmonic to geometrical methods: οὐ γάρ ἐστιν ὥσπερ ἐπὶ τῶν διαγραμμάτων εἴθισται λέγεσθαι· ἔστω τοῦτο εὐθεῖα γραμμὴ . . .⁵⁹ He admits the irrelevance of such hypotheses in the field of harmonics because harmonics relies on accurate perception. Yet he attempts theorems of this sort at the end of the Principles in each book, and throughout Book III. Six of the seven axioms concerning succession in Book I are introduced with the imperative form ὑποκείσθω, and Axiom I (concerning succession) in the second book uses the imperative twice.⁶⁰ Furthermore, between the two books imperative forms are used sixteen times.⁶¹ However, rather than using the mood to pose a hypothetical situation, Aristoxenus tends to use it to pose definitions in the Principles. Typical is the definition of the *pyknon* which uses an imperative each time: πυκνὸν δὲ λεγέσθω . . . (24.12/50.15).

In Book III, the theorems use the imperative in two different ways: theorem (i), for example, concerning conjunction and disjunction, employs it in a definitive way comparable to its use in the Principles.⁶² All the other instances reflect the use of the mood in geometrical works, using hypothetical examples.⁶³ Theorem (viii) is typical of this latter method. It poses a negative

statement and then speculates about the possible implications. δύο δὲ δίτονα ἐξῆς οὐ τεθήσεται. τιθέσθω γάρ . . . ⁶⁴ This constructs a sort of *reductio ad absurdum* argument, or at least an argument leading to the non-melodic. Although Aristoxenus attempts to imitate the language of a demonstrative science throughout the sections concerned with principles, this is not practical until the proofs presented for the theorems of the third book.

The presentation of the set of axioms in each book is quite different. As we have seen in other areas of the work, there is better organisation and less repetition in Book II's version, although there is more discursive material. The three axioms of Book II are accompanied by some explanation, the last of them including an extensive "proof" that the fourth is two and a half tones.

The set of axioms of the first book is presented with no explanation, nor any hint of its implications. A tetrachordal structure is implied throughout the statements, but is nowhere specified and so, without a general summary of the system of conjunct and disjunct tetrachords, Aristoxenus' seven axioms are insufficient to determine the laws of melodic succession. At the same time, there is considerable overlap between them. While these closing statements of Book I are an attempt to codify the rules of melody they merely tend to re-define the notions of succession, consecution and incomposite intervals. The exception to this is the second statement (29.6), the only one repeated almost exactly from Book I to Book II (54.1–8, Axiom I). It is noticeable that this is also the only one of the three axioms in Book II which uses the imperative mood (ὑποκείσθω) common in those of the first book.

The Principles of Book II conclude with three fundamental axioms which, unlike those of Book I, are surrounded by considerable supplementary material. They assume an acceptance of the information set out in the preceding section on genera, intervals, notes, and *systemata* as well as an understanding of the defining comments on succession and consecution.

Axiom I

ἐν παντὶ δὲ γένει ἀπὸ παντὸς φθόγγου διὰ τῶν ἐξῆς τὸ μέλος ἀγόμενον καὶ ἐπὶ τὸ βαρὺ καὶ ἐπὶ τὸ ὀξύ ἢ τὸν τέταρτον τῶν ἐξῆς διὰ τεσσάρων ἢ τὸν πέμπτον διὰ πέντε σύμφωνον λαμβανέτω.

Let it be accepted that in every genus, as the melodic sequence progresses through successive notes both up and down from any given note, it must make with the fourth successive note the concord of a fourth or with the fifth successive note the concord of a fifth (54.1–8).

Axiom II

δεῖ γάρ τοις τοῦ αὐτοῦ συστήματος τετραχόρδοις ἔχομένοις δυοῖν θάτερον ὑπάρχειν, ἢ γὰρ συμφωνεῖν πρὸς ἄλληλα, ὥσθ' ἕκαστον ἑκάστῳ συμφωνον εἶναι καθ' ἣν δήποτε τῶν συμφωνιῶν, <ἢ> πρὸς τὸ αὐτὸ συμφωνεῖν μὴ ἐπὶ τὸν αὐτὸν τόπον συνεχῇ ὄντα ὥς συμφωνεῖ ἑκάτερον αὐτῶν.

Tetrachords that belong to the same *systema* must have one or other of two properties. Either they must be concordant with one another, so that each note of the one forms some concord with the corresponding note of the other, or they must both be concordant with the same tetrachord, each of them being continuous with the one with which they are concordant, but not in the same direction (54.25–32).

Axiom III

ἐπεὶ δὲ τῶν διαστηματικῶν μεγεθῶν τὰ μὲν τῶν συμφώνων ἦτοι ὅλως οὐκ ἔχειν δοκεῖ τόπον ἄλλ' ἐνὶ μεγέθει ὠρίσθαι, ἢ παντελῶς ἀκαριαῖόν τινα, τὰ δὲ τῶν διαφώνων πολλῶ ἦττον τοῦτο πέπονθε.

Of the magnitudes of intervals, those of the concords appear to have either no range of variation at all, being determined to a single magnitude, or else a range which is quite indiscernible, whereas those of the discords possess this quality to a much smaller degree (55.2–8).

Aristoxenus acknowledges the similarity of the first two axioms and their inadequacy as the criteria for melodic sequences (many melodic structures could conform to these principles while still being unmelodic according to Aristoxenus) but states that they are essential prerequisites.⁶⁵ Axiom I is the most important as it is the principle used to prove many of the theorems of Book III, but only in a negative manner. It is only able to rule out would-be melodic structures as non-melodic rather than establish the opposite: οὐ δεῖ δ' ἄγνοεῖν, ὅτι οὐκ ἔστιν αὐτάρκες τὸ εἰρημένον πρὸς τὸ ἐμμελῶς συγκείσθαι τὰ συστήματα ἐκ τῶν διαστημαμάτων· οὐδὲν γὰρ κωλύει συμφωνούντων τῶν φθόγγων κατὰ τοὺς εἰρημένους ἀριθμοὺς ἐκμελῶς τὰ συστήματα συνιστάναι, ἀλλὰ τούτου μὴ ὑπαρχόντος οὐδὲν ἔτι γίγνεται τῶν λοιπῶν ὄφελος.⁶⁶

All three axiomatic statements emphasise the tetrachord and the fourth. The third axiom is unusual in that it does not directly concern succession but refers to the perception of concords. It highlights the primary role of the concords in the melodic framework, and it is the only discussion in the *Harmonics* which indicates that the concords are in some fundamental way different

from other intervals. The central role of the fourth is confirmed in the subsequent lengthy construction which shows how we may determine whether or not the fourth is exactly two and a half tones. This was stated earlier in the *Principles* (46.2) and presented as immediately apparent to perception. In this way it fulfils the qualification for being a principle, but Aristoxenus nevertheless bothers to construct an empirical procedure for assessing it. This perhaps reveals an uncertainty about its exact magnitude. While he is confident that it functions as two and a half tones, he knew that from the perspective of Pythagorean mathematical physics it is slightly less (28.14, cf. 55.3–6).⁶⁷

In sum, a musical structure which involves a series of conjunct and disjunct tetrachords is assumed throughout the principles, but nowhere stated. Aristoxenus avoids making this general structure explicit⁶⁸ even though his axioms are only meaningful in the context of this fundamental outline of fourths and fifths. One of the implications of these axioms is that within a *systema* there can only be similar tetrachords, effectively precluding the combination of genera, but this too is never explicitly stated. Although only the three axioms from Book II (and the final seven axioms of Book I) have direct relation to the proofs for the theorems of Book III, the principles as a whole (from 19.18 and 44.21) are needed because in these passages musical structures are described, including the fixed fourth and its movable infixes, the concords, the genera and the *pyknon*.⁶⁹ The whole section, while it is not all used as proof for the theorems of the third book, nevertheless conforms to Aristotle's criteria for principles ("true, primary, immediate, better known than, prior to, and causative of the conclusion")⁷⁰ and is essential to understanding the theorems of the third book.

The *Principles* are set out in both books of the *Harmonics* (19.18–30.8 and 44.21–58.3) and display the basic laws of succession. They show the fundamental structures in harmonic theory from the perspective that they are determined by the natural laws of melody. The more refined and better organised presentation of Book II, with its attempt at more universal and abstract propositions than Book I, leads naturally into the theorems of Book III. Indeed, the Elements of *Harmonics* set out in Book III are dependent on the exposition of Book II (and cannot follow from Book I) because of their assumption of the idea of *dynamis*.

7c. *Demonstrated propositions*

The ambition of Book III of the *Harmonics* is the exposition of propositions derived from the principles of the previous book in the manner of the axiomatic-deductive science proposed in *Posterior Analytics*.⁷¹ It contains four preliminary theorems on succession, then moves into particulars: the positions

possible for specific notes, and possibilities of progression from them. The subject of these theorems in the *Harmonics* is primarily succession, and the treatise breaks off at the point when Aristoxenus appears to be about to launch into a discussion of scale systems. The final theorem concerns the forms of tetrachords, from which we can speculate that it was followed perhaps by that of pentachords, octaves, and the description of the greater and lesser perfect systems. It is notable that the theorems refer only to the parts of harmonics which have already been treated in the first two books, genera, intervals, notes, and the beginning of a discussion on *systemata*.

Unfortunately, the demonstrations provided with the theorems of Book III are often problematic, since the methods that Aristoxenus uses to prove the validity of melodic sequences involve questionable reasoning. Further, it is in this section of the treatise that the full implications of his attribution to melody of a natural and necessary cause become apparent. It leads him to the view that the structures of scale systems can be demonstrated as natural necessities, on the basis on a set of undeniable axioms. To a modern reader it may seem clear that while the conventions embedded in a particular musical tradition can be brought together to provide a general foundation for the 'rules' that melodies will follow within the relevant culture, they will not have the status of necessary principles. But neither Aristoxenus nor any other Greek theorist adopts a 'conventionalist' position of that sort.

Aristoxenus' theorems on succession demand the assumption of a naturally occurring melodic structure of conjunct and disjunct tetrachords which is assisted in its theoretical expression by the previously established concept of *dynamis*. However, the choice he has made to discuss theorems in terms of interval magnitudes rather than using the actual names of notes undermines the dynamic methodology established by the second book. This is particularly apparent in the discussions concerning progressions to and from tones: in the chromatic and enharmonic genera the tone can only refer to the disjunctive tone, while in the diatonic it can be part of the tetrachord. This results in repetition and clarification of theorems in terms of the diatonic genus, and the exposition becomes unnecessarily convoluted and difficult to follow.

Three of the first four theorems of Book III are concerned with conjunction and disjunction. They are essentially definitive in nature, and contribute to the explanation of succession in general terms before the specific instances with which many of the later theorems are concerned. The demonstration of the first theorem (τὰ ἐξῆς τετράχορδα ἢ συνῆπται ἢ διέζευκται⁷²) is based on Axiom I and this justifies its status as a theorem rather than a principle, despite the defining imperative mood. It also refers to the second axiom of Book II, concerning relationships between tetrachords.

Theorem (ii) (ἀσύνθετον δ' ἐστὶ διάστημα τὸ ὑπὸ τῶν ἐξῆς φθόγγων περιεχόμενον⁷³) is essentially a reiteration of the definition of succession which appeared in the principles of Book II: οἱ <τοῦ> προειρημένου ἀριθμοῦ μέρη περιέχοντες φθόγγοι ἐξῆς ἀλλήλων ἔχονται.⁷⁴

Many of the theorems refer back to already proven theorems, even when this is not the most efficient method of proof. The two most constantly referred to are (v) and (vi):

Theorem (v)

πυκνὸν δὲ πρὸς πυκνῷ οὐ μελωδεῖται οὔθ' ὅλον οὔτε μέρος αὐτοῦ.

No *pyknon*, neither a whole *pyknon* nor a part of one, is melodically adjacent to another *pyknon* (62.33–63.1).

Theorem (vi)

τῶν δὲ τὸ δίτονον περιεχόντων ὁ μὲν βαρύτερος ὀξύτατός ἐστι πυκνοῦ ὁ δ' ὀξύτερος βαρύτερος.

Of the notes bounding the ditone, the lower is the highest note of a *pyknon*, the higher the lowest note of a *pyknon* (63.5–6).

Theorem (v) is concisely proven by Axiom I. Theorem (vi) proposes the alternation of ditone and *pyknon* as a valid *systema*, which seems fair enough. However, the way in which it is used by Aristoxenus in subsequent theorems is considerably more complex. As it stands, it only describes conjunct tetrachords, but later it is referred to in the context of disjunct tetrachords. In such cases the disjunctive tone is treated as though it were both present and absent, leading to contradictory hypothetical structures. Barker has set out a plausible logic behind this apparent contradiction, which is centred around the potential of notes to progress to certain notes.⁷⁵

The recourse to these theorems is first seen as early as theorems (vii) and (viii). The first of these asserts οἱ δὲ τὸν τόνον περιέχοντες ἀμφοτέροί ἐσι πυκνοῦ βαρύτεροι.⁷⁶ It is clear that the highest note of the tone is the lowest of the *pyknon*, but the lowest note of the tone is really no part of the *pyknon* at all. The reasoning is as follows: the lowest note of the tone is the highest note of the ditone, the highest note of the ditone is the lowest note of the *pyknon* (vi), therefore the lowest note of the tone is the lowest note of the *pyknon*. Aristoxenus has used a theorem referring to conjunct tetrachords (vi) as the proof for a theorem concerning a disjunct tetrachord (vii) and this curious manoeuvre is repeated throughout the third book. Theorem (vii), in

fact, can be treated as true only under the very complex and debatable interpretation of its meaning, and of the way in which it is to be applied.⁷⁷ Similarly, the eighth theorem refers to both (v) and (vi) as it states that two ditones will not be placed in succession (63.33). It has been established that the lowest note of the *pyknon* is the highest note of the ditone and vice versa (through vi). If there were two successive ditones the highest note of the lower ditone would be the lowest note of a *pyknon* (vi) and the lowest note of the higher ditone would also be the highest note of a *pyknon* (again, vi). Therefore, Aristoxenus argues, there would be two *pykna* in succession, which is unmelodic (v). It would have been easier to say that a succession of two ditones flouts Axiom I, as was the proof for theorem (v). However, Aristoxenus chooses to refer to previously demonstrated theorems.

In the same way, theorems (xii), (xiii) and (xiv)⁷⁸ are proven by reference to the established theorems (vi) and (v), and are typical of the cumulative demonstration of Book III. They attempt to codify the relative positions of intervals and are, in their turn, the basis for the proofs of theorems (xvii), (xviii) and (xix)⁷⁹ which try to codify the number of progressions up and down from each interval.

Most of Aristoxenus' theorems are expressed in the enharmonic genus and examine the possibility of progressions between its three basic interval structures: the *pyknon* (whose two *dieses* are generally taken as a single entity), the ditone, and the disjunctive tone. Theorems concerned specifically with genera tend to focus on differences between the diatonic genus and the enharmonic and chromatic genera, on the fact that the diatonic does not contain a *pyknon* and that its most familiar division includes two tones apart from the disjunctive tone. Theorems (xv, 66.19) and (xvi, 66.28) specifically describe the interval sequences possible in the diatonic genus. The first—that a semitone on both sides of a tone is not melodic—can be (and is) proven with Axiom I, but the second—that there can be three tones in succession in the diatonic genus—only does not violate Axiom I, which Aristoxenus previously (54.11–18) has admitted is not sufficient proof that a sequence is melodic but does not admit as much here.

Where a theorem is not specific about genus, the term “ditone” is used to indicate the highest interval of the tetrachord, the term “*pyknon*” for the lower two, even in the diatonic.⁸⁰ This highlights the connection between the third book of the *Harmonics* and the second, because this type of shorthand is only possible in the context of a dynamic analysis of melody, and it is justified in a digression following theorem (xix): δεῖ γὰρ ἕκαστον τῶν ἐν τῇ μουσικῇ καθ' ὃ πεπερασταὶ κατὰ τοῦτο τιθέναι τε καὶ τάττειν εἰς τὰς ἐπιστήμας, εἰ δ' ἄπειρόν ἐστιν ἕαν. κατὰ μὲν οὖν τὰ μεγέθη τῶν

διαστημάτων καὶ τὰς τῶν φθόγγων τάσεις ἄπειρά πως φαίνεται εἶναι τὰ περὶ μέλος, κατὰ δὲ τὰς δυνάμεις καὶ κατὰ τὰ εἶδη καὶ κατὰ τὰς θέσεις πεπερασμένα τε καὶ τεταγμένα.⁸¹

The relevance of this digression on the dynamic nature of melody becomes apparent in the following theorems (xx-xxv) which are specifically concerned with the individual notes of the *pyknon*, and therefore are strictly related to the chromatic and enharmonic genera. As Aristoxenus has just stated in the digression following (xix), because the function of each note is more significant than the measured placement, these theorems apply *mutatis mutandis* equally to the diatonic genus.

Despite this, Aristoxenus insists on defining his theorems through interval sizes, such as ditone or tone, rather than interval function. Admittedly, he does use the dynamic term *pyknon*, but he does not, for instance, make clear the role of the disjunctive tone compared to a tone within the diatonic tetrachord.

There are even more examples of the fact that Aristoxenus does not use the most efficient argument to prove his theorems. Two theorems concerning *pykna* (xxiv and xxv) are justified by another return to the arguments of theorems (v) and (vi). Theorem (xxiv) states that the middle note of the *pyknon* has only one possible progression either way. This is argued through the logic that the middle note of the *pyknon* must have a *diesis* on either side because any other interval in that position would lead to overlapping *pykna*. Aristoxenus does not refer to the more evident fact (i.e. principle) that if the middle note of the *pyknon* did not have a *diesis* on either side it would not be a *pyknon*, as it was defined in the principles at 50.18. Once more, we find the same practice in theorem (xxv) (ὅτι δ' οὐ τεθήσονται δύο φθόγγοι ἀνόμοιοι κατὰ τὴν τοῦ πυκνοῦ μετοχὴν ἐπὶ τὴν αὐτὴν τάσιν ἐμμελῶς, δεικτέον⁸²) which he tries to prove on the grounds that one of the two notes sharing the same pitch in a *pyknon* must be the middle note which has limited options for progression (based on xxiv) and violating this principle would lead to two *pykna* in succession (apparently), which would violate (v). One must assume that Aristoxenus had reasons for offering these problematic and circuitous proofs where much simpler ones are evidently available, but it is far from obvious what those reasons could have been.

The final theorem moves on to a systematic enumeration of forms of the fourth, and we can safely presume that this would have been followed by enumeration of the forms of the fifth and octave. It demands adherence to Axiom I, operating within a presumed structure of the greater or lesser perfect systems, but outside the moveable notes of the tetrachords which have dictated the theorems up until this point.

To sum up, Aristoxenus has applied to melody the techniques of Aristotelian science as found in several sources. The prime text is the *Posterior Analytics*, which sets out a program of first principles and demonstrable theorems, but he has clearly been influenced by thoughts represented in the *Metaphysics*, which includes extended general discussions of science. The success of the *Harmonics* is mixed. Socially contrived aspects of a particular phenomenon have limited opportunity for axiomatic expression. Aristoxenus clearly has problems in attempting to establish the inviolability of a dynamically conceived harmonic science to compete with the Pythagorean mathematical principles of music.

The *Harmonics* applies some principles of Aristotle's scientific methodology, in which demonstration is essential and must be set within the terms of the science in question. Aristoxenus makes very clear his perception of himself as an innovator in the science of harmonics, and is determined to keep his study within the bounds of the science as he defines it. However, his ambition to rely on first principles and demonstration in order to establish the theorems of the science is undermined by the nature of music itself. While it is possible to establish the mathematical relationships of vibration or string length to musical intervals, it is not clear how it could be shown that the principles underlying a theorem such as "two ditones cannot be placed in succession" are independent of transitory conventions. He cannot reject such musical structures on the basis that they are impossible, only that they are "unmusical." The non-primary propositions must be derived from principles which explain why they are true, yet Aristoxenus offers no defence of his assumption that the principles themselves are true 'by nature' and not merely 'by convention.'

CONCLUSION

The *Harmonics* aims at a description of melodic space which is independent from non-musical phenomena, and aspires ultimately to create a system capable of axiomatic expression. Aristoxenus does not overlook the fact that his system can only appeal to the concept of the non-musical (as opposed to the irrational, or the impossible) but he does not admit that the form of melodic structure which he describes is merely customary rather than inevitable. According to Aristoxenus, melody is necessarily in the form that it is, and musical space can only be divided in the way that it is. Leaving on one side the issue of conventionality, Aristoxenus' treatise establishes that there is a structure to melody which is ordered, intrinsic, and capable of being understood without reference to extra-musical phenomena. It is with the concept of *dynamis* that this is able to be expressed and which establishes harmonics as an

independent science. From this point all the other divisions of musical science can be asserted and maintained.

The revision of Book I results in a much clearer exposition of the topic in Book II, and the inconsistencies between the introduction of Book I and the body of the text present some motivation for the abandonment of that draft and the renewed attempt at the treatise. Aristoxenus seems to have refined his own concept of the subject in several ways, the most obvious sign of which being the concept of *dynamis* which permeates Book II, but whose absence from Book I becomes unsustainable. It is significant that the text ends during the discussion of continuity and succession, which cannot do without this concept if Aristoxenus' understanding of it is to be made clear.

Also important in the revision is the inclusion of melodic composition as part of harmonic science. The absence in Book II of acoustic discussions, historical comments and any other area not directly relevant to harmonic science show how the author has refined his definition of the topic. In addition, the greater organisation of the text and considerably expanded methodological discussion indicate that the first book became a draft copy for the second. Another motivation for the revision appears to be the confusion of Aristoxenus' audience, who, while apparently familiar with some musical jargon, were somewhat nonplussed by Aristoxenus' functional conception of notes in musical space.

Although there are references forward from the first book to more detailed discussions which often do not appear, and there are more sophisticated concepts involved in the second and third books which may confirm the preliminary or introductory status of the first book. This indicates a redrafting caused by a gradual shift in the author's own thinking rather than a functional division within a continuous argument. There is, admittedly, evidence for claiming that the work is unified. The extended definitions of basic concepts in Book I, which are omitted from Book II contribute an important discussion of the essential element of music, and they are cited by later theorists. However, against the unity of the treatise is the marked repetition of structure between the two books, and the inclusion of the dynamic concept of notes within *systemata* while maintaining this structure.

The probability that Book II is a revision of Book I (and the nature of this revision) suggests that Aristoxenus' purpose in his musical writings is to establish order in musical investigation through an Aristotelian-style science. While the Pythagoreans seek to codify the numerical arrangement of music as a reflection of a higher cosmological organisation, Aristoxenus' objective is to demonstrate order in melodic systems without referring to extra-musical phenomena. He attempts to extract musical enquiry from general scientific or

philosophical enquiry, and to divide the subject of music as a whole into smaller independent units. The *Harmonics* grants autonomy to the subject as a science within, but not subordinated to, the more general study of music. There are passing discussions in the harmonic treatise which relate to the methodology of other areas of musical enquiry. The common contention of these brief comments is that each aspect of musical investigation has its proper place, and the surviving fragments of Aristoxenus' musical works outside the *Harmonics* are consistent with this approach. The selection not only of material, but also of methodology, proper to a particular enquiry is one of the distinctive elements of his scholarship in this field, and the application of this method by Aristoxenus to other musical subjects will be discussed in the following two chapters.

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Chapter Four

The *Rhythmics*

INTRODUCTION

In the *Harmonics* Aristoxenus divides the sphere of music into smaller areas of investigation, including rhythm, metre and instruments.¹ While nothing remains from any writings on metrics and little on instruments, a substantial fragment does exist from the treatise on rhythmics which is the subject of the present chapter. The *Rhythmics* offers an obvious counterpart to the work on harmonics and, since Aristoxenus is consistent in many methodological techniques across both treatises, their temporal and intellectual relationship must be discussed.

As little theoretical discussion remains on rhythm, the subject is often subordinated to the study of metre, and its role in music takes second place to its context in Greek verse. Although the metre of a verse alone is not a complete or totally accurate indication of how its rhythm was composed,² our knowledge of the rhythm of a musical setting is often dependent on the text and its metre, since such a small fraction of poetry survives with any notation. In this way we are compelled to associate the metre of the verse with its possible rhythmical setting. Similarly, theoretical discussions of rhythmical structure which survive from before Aristoxenus are closely associated with metrical structures in verse. In fact, a deliberate theoretical division between rhythm and metre appears only to have been established by Aristoxenus himself.

Fortunately, despite the brevity of the fragment from Aristoxenus' *Rhythmics* there is other material available concerning his theories on the topic which extends our understanding of the subject significantly. This later work is of varying reliability, but in many cases its evidence can be corroborated. However, before we look at the *Rhythmics* itself, or the material dependent on it, it is important to examine what evidence there is concerning the status of the subject in the fifth and fourth centuries.

1. PRE-ARISTOXENIAN SOURCES: ARISTOPHANES, PLATO AND ARISTOTLE

While Aristoxenus' harmonic science was both a development from, and a reaction against, earlier investigations into the subject, methods of enquiry into rhythmic structures appear to have been less firmly established.³ The discussion concerning harmonics appears to have been taking place fairly continuously since the sixth century, whereas there is little evidence for a long tradition of scholarship in the field of rhythmic and the discussions which do occur are associated very strongly with poetry.⁴

One fillip to the discussion of rhythm, albeit limited, appears to have been evolution in musical practice. An early example of compositional innovation is noted by Ps.-Plutarch (possibly citing Heraclides Ponticus or Aristoxenus himself) who remarks that Lasus of Hermione εἰς τὴν διθυραμβικὴν ἀγωγὴν μεταστήσας τοὺς ῥυθμούς, . . . εἰς μετάρθῃσιν τὴν προυπάρχουσαν ἤγαγεν μουσικὴν.⁵ Considerably more rhythmic variation is evidenced in the later fifth century when dramatic innovations in musical practice, typical of the so-called "new" music, affected metre and rhythm as well as having its more notorious effects on melody.⁶ The fragment from the *Chiron* of Pherecrates,⁷ although it concentrates on *harmoniai* and does not mention rhythmic innovation specifically, cites a litany of music's woes under several composers including Melanippides, Cinesias of Attica, Phrynis and, most terrible of all, Timotheus. Timotheus' own boasting in the fragment from the *Persae* provides an early poetic source for the separate mention of metre and rhythm: νῦν δὲ Τιμόθεος μέτροις | ῥυθμοῖς τ' ἐνδεκακρουμάτοις | κίθαριν ἐξανατέλλει.⁸

A fourth-century source (again possibly Heraclides) notes that a simple musical style was maintained from the time of Terpander to the time of Phrynis (i.e. from the seventh to the fifth centuries) and compares it to the innovations of contemporary—that is, fourth-century—performance: οὐ γὰρ ἔξῃν τὸ παλαιὸν οὕτως ποιεῖσθαι τὰς κιθαρῳδίας ὥς νῦν οὐδὲ μεταφέρειν τὰς ἁρμονίας καὶ τοὺς ῥυθμούς.⁹ Dionysius of Halicarnassus also comments on the liberal rhythmic aspect in dithyrambic compositions of "new" musicians: καὶ τοῖς ῥυθμοῖς κατὰ πολλὴν ἄδειαν ἐνεξουσιάζοντες διετέλουν, οἳ γε δὴ κατὰ Φιλόξενον καὶ Τιμόθεον καὶ Τελεστήν.¹⁰

The performance of "new" music and melodic and rhythmic freedom in verse settings appear to have caused the ever-conservative Plato some concern. His brief review of rhythm in the *Republic* (398d ff.) attempts to assert the supremacy of text over rhythm, and advocates the maintenance of natural lengths

of syllables in rhythmic composition: καὶ μὴν τὴν γε ἁρμονίαν καὶ ῥυθμὸν ἀκολουθεῖν δεῖ τῷ λόγῳ.¹¹ Some centuries later, the upheaval caused by the innovations of this new music seems to have settled and the innovations passed into standard practice. In the first century BCE Dionysius of Halicarnassus comments on the relationship of text and its accompanying music in comparison to the treatment of syllable lengths in prose: ἡ μὲν γὰρ περὶ λέξεις οὐδενὸς οὔτε ὀνόματος οὔτε ῥήματος βιάζεται τοὺς χρόνους οὐδὲ μετατίθησιν, ἀλλ' οἷας παρείληφεν τῇ φύσει τὰς συλλαβὰς τὰς τε μακρὰς καὶ τὰς βραχεῖας, τοιαύτας φυλάττει· ἡ δὲ μουσικὴ τε καὶ ῥυθμικὴ μεταβάλλουσιν αὐτὰς μειοῦσαι καὶ παραύξουσαι, ὥστε πολλάκις εἰς τὰναντία μεταχωρεῖν· οὐ γὰρ ταῖς συλλαβαῖς ἀπευθύνουσι τοὺς χρόνους, ἀλλὰ τοῖς χρόνοις τὰς συλλαβὰς.¹²

Because of the close association between rhythm and metre the two are often distinguished from melody but not from one another. More often, the natural antithesis between the harmonic structure of melody and the rhythmic structure of language is emphasised. Plato's very general definition of the elements of choral song places rhythm in opposition to melody in a way typical of this antithesis: τῇ δὲ τῆς κινήσεως τάξει ῥυθμὸς ὄνομα εἶη, τῇ δ' αὖ τῆς φωνῆς, τοῦ τε ὀξέος ἅμα καὶ βαρέος συγκεραννυμένων, ἁρμονία ὄνομα προσαγορεύοιτο, χορεία δὲ τὸ ξυναμφότερον κληθεῖη.¹³

Plato mentions both rhythm and metre with reference to bodily movements in the *Philebus*,¹⁴ while in the *Gorgias* (502c) and the *Republic* (601b) he mentions all three elements of music: rhythm, metre and *harmonia*. In an argument against solo instrumental music (*Laws* 669d ff.), Plato emphasises the interdependence of words, melody and rhythm. In the discussion following, he specifically condemns performers of innovative instrumental music, whose melodies are unsupported by words: διασπῶσιν οἱ ποιηταὶ ῥυθμὸν μὲν καὶ σχήματα μέλους χωρὶς, λόγους ψιλοῦς εἰς μέτρα τιθέντες, μέλος δ' αὖ καὶ ῥυθμὸν ἄνευ ῥημάτων, ψιλῇ κιθαρίσει τε καὶ αὐλήσει προσχρώμενοι, ἐν οἷς δὲ παγχάλεπον ἄνευ λόγου γιγνόμενον ῥυθμὸν τε καὶ ἁρμονίαν γινώσκειν ὅ τί τε βούλεται καὶ ὅτῳ ἔοικε τῶν ἀξιολόγων μιμημάτων.¹⁵ This passage highlights the lack of specific distinction between rhythm and metre. Although in this instance Plato uses “metre” to refer to examples dependent on the existence of words, and “rhythm” to refer to wordless examples, there is no specified theoretical separation of the two concepts and they appear to be almost equivalent. Indeed, the term “metre” is employed rarely by Plato who, throughout his writings, uses “rhythm” to cover both aspects in his discussions of rhythm and harmony.¹⁶

For Aristotle, the emphasis remains on the context of language, and the essential difference between rhythm and metre appears to be one of sophistication. In the *Ars Rhetorica* (1408b21 ff.) he discusses rhythm only in relation to its effect in rhetorical speech and states that prose should be rhythmical to a certain extent, but if it is too metrical it becomes verse. The types of rhythm he names are heroic, iambic, trochaic and paeonic. The last of these alone is acceptable for writing of prose: ἀπὸ μόνου γὰρ οὐκ ἔστι μέτρον τῶν ῥηθέντων ῥυθμῶν, ὥστε μάλιστα λανθάνειν.¹⁷ The paeonic rhythm, Aristotle suggests, should be used to give strength to the beginning or to the end of sentences. Like Plato, Aristotle supports a distinction between rhythm and melody which contrasts with the overlapping roles of rhythm and metre. In the *Politics* Aristotle anticipates a discussion of rhythm and *harmonia* (but not metre) and their use in education (1340b20 ff.).

Evidence for the technical theoretical discussion of rhythm comes indirectly from two literary sources. In a satirical passage in the *Clouds* (635–660), Aristophanes employs technical rhythmical terms as he presents Socrates in the struggle to educate Strepsiades. Socrates offers three options for study: *metra*, *epe* and rhythms.¹⁸ While rhythm and metre are named separately here, none of these subjects differentiated from one another on a theoretical level, and Aristophanes uses sufficiently ambiguous language to be able to maintain the comic pretext of Strepsiades' obstinate misunderstanding. As examples of *metra* Socrates includes trimeter and tetrameter, and among types of rhythm the κατ' ἐνόπλιον and κατὰ δάκτυλον.¹⁹ The assumption that Aristophanes' *metra* are the iambic trimeter and the trochaic tetrameter is reasonable but not able to be confirmed, as they are not specified in the passage and the term *metra* merely seems to refer to the number of units in a metre.²⁰ The technical terms, while indicating the esoteric nature of the subject for the average Strepsiades, must have been in sufficient use for the audience to get the joke.

The passage of Aristophanes and a section from Plato's *Republic* written decades later cover a surprisingly similar area of ground. Having initially referred to rhythm in relation to rhetorical style (397b), then more specifically as a counterpart to the discussion of suitable *harmoniai*, Plato presents a jumbled list of rhythmic terms, attributing his knowledge to Damon: οἶμαι δέ με ἀκηκοέναι οὐ σαφῶς ἐνόπλιόν τε τινα ὀνομάζοντος αὐτοῦ ξύνθετον καὶ δάκτυλον καὶ ἡρώον γε, οὐκ οἶδα ὅπως διακοσμοῦντος καὶ ἴσον ἄνω καὶ κάτω τιθέντος, εἰς βραχύ τε καὶ μακρὸν γιγνόμενον, καὶ, ὡς ἐγὼμαι, ἱαμβον καὶ τιν' ἄλλον τροχαῖον ὠνόμαζε, μήκη δὲ καὶ βραχύτητας προσῆπτε.²¹ Plato's rhythmical adjectives refer back to the ῥυθμούς of the previous sentence; consequently in the account of the

Republic there is no mention of metre and only one passing reference to feet (400c).²² Like the passage from Aristophanes, it includes the (composite) *enoplion* and the dactyl, but also several other rhythms; the heroic, iambic, trochaic, and such technical terms as ἄνω and κάτω.²³

While both passages make use of technical rhythmical terminology, neither gives these terms clear or systematic explanation, and the emphasis is on the relationship of verse and rhythm. The limited and confusing presentation of concepts, and comic use of incomprehensible musical jargon, particularly in Aristophanes, indicates the specialised level of this discussion. While the audience may understand that Socrates and Strepsiades are talking at cross-purposes, they would not necessarily be fluent in the use of these rhythmic terms. This contrasts with Plato's presentation of material related to harmonic science in the previous section of the *Republic* (398e-399e), in which technical terms concerning specific genera and *harmoniai* are freely used with the apparent understanding that their meaning would be familiar to the audience.

Importantly, both passages refer to the aesthetic and ethical value of rhythms. In the *Clouds* Socrates demands an opinion on the aesthetic value of different metres: ἄλλ' ὅτι κάλλιστον μέτρον | ἢ γέϊ, πότερον τὸ τρίμετρον ἢ τὸ τετράμετρον;²⁴ In the *Republic*, Glaucon recalls that there are three forms (εἶδη) which are combined to make up feet, although he cannot relate the corresponding ethos of each.²⁵ The fact that an aesthetic and ethical judgement of different rhythms is requested by Socrates in each instance, or indeed the fact that the subject is subject for satire, indicates that at least some theory concerning the nature of rhythm had appeared by the late fifth century. Certainly Damon, who is referred to specifically in the *Republic*, appears to have developed a theoretical system concerning the ethos of certain rhythms, corresponding to his theories concerning *harmoniai*, yet his opinions on the subject are for the general public at that time still opaque.²⁶

Therefore there is evidence for some theoretical discussion of rhythm well before the appearance of Aristoxenus' treatise, although from the evidence of Aristophanes, Plato and Aristotle it appears that a clear distinction between metrics and rhythmics is seldom made, and in fact there is barely any difference in their use. The conscious confusion in their accounts reflects a dramatic method, but it also suggests that the terminology for the science was in the fifth century not firmly established. While Aristotle's approach does not satirise the esoteric nature of technical jargon as do the passages of Aristophanes and Plato, the exposition is still limited. In no way does he attempt to present a complete enumeration or analysis of rhythmical formulae but merely describes the subordinate role of rhythm in the broader context of rhetorical techniques.

The active development in rhythmic as well as melodic composition and performance during the late fifth and early fourth centuries does not seem to have encouraged an immediate corresponding blossoming in theoretical debate concerning rhythm.²⁷ It seems that there was some discussion, but its vague and sketchy nature indicates the still-esoteric nature of the topic. This is markedly different from references to harmonic theory in which Plato and Aristotle, though neither of them is an expert on the subject, show that they are obviously familiar (and expect a familiarity in their audience) with technical terms referring to harmonic theory. Both are able to recommend specific *harmoniai* and Plato includes the ratio calculations of the diatonic scale in the *Timaeus*.²⁸ Perhaps the comparative lack of interest in the subject reflects the absence of such an impetus as the discovery of the numerical ratios of consonances by the Pythagorean theorists and their subsequent application to musical scales. While the discoveries of the sixth-century Greeks in Italy had had time to develop into a science of such a scope as harmonics, the discussion on rhythm stimulated by the “new” music perhaps was still experimental.

2. SOURCES FOR THE RHYTHMIC THEORY OF ARISTOXENUS

While the terms of rhythm and metre are becoming established, the distinction between the two disciplines is still not entrenched. Aristoxenus appears to be the first to attempt the study of rhythemics systematically and independently from metrics. As with his exposition of harmonic science, he isolates his topic from extraneous discussions and attempts to establish the limitations of rhythemics as an autonomous object of investigation. His work in the *Rhythmics* appears to follow a similar method to that of the *Harmonics* and this includes a separation between the disciplines of rhythemics and metrics (32.4–9), a division not commonly acknowledged by earlier sources. The rejection by Aristoxenus of the dependence of rhythmic investigation on language (compared with the lack of clear differentiation in earlier discussions between rhythm and metre) may indicate one way in which the change in musical practice and rhythmical freedom brought about by “new music” has made an impact on the language describing rhythmical systems and how they were understood.

What remains of the *Rhythmics* consists only of four folios from the second book of the treatise, discussing several theoretical concepts, and listing some fundamental rhythmic structures. It distinguishes rhythm itself from the material capable of being put into a rhythm, discusses the unit of measurement and some features of rhythmic composition. Finally there is a discussion of the foot and an enumeration of its different forms, followed by examples. This last section of Aristoxenus’ *Rhythmics* appears to operate on a purely quantitative

level, emphasising numerical relationships between the *arsis* and *thesis* of each foot, and disclosing little about stress or dynamic function.

It is not really possible to draw firm conclusions about the contents of the treatise as a whole on the basis of this extract. Fortunately, there are several other sources for Aristoxenus' theory of rhythmics which supplement these few pages. As with the *Harmonics*, many later writers were dependent on the rhythmic treatise of Aristoxenus for their own theories. Direct influence is apparent in Psellus' *Introduction to the Study of Rhythm* and in the *Fragmenta Neapolitana*, since the subject matter and specific passages in both of these works closely follow parts of the existing *Rhythmics*.²⁹ The extensive *De Musica* of Aristides Quintilianus also provides evidence for an Aristoxenian treatment of rhythm and metre, and dependent on this treatise is the superficial summary of rhythmic concepts in Book IX of Martianus Capella's *De nuptiis Philologiae et Mercuri*.

Aristides' treatise is a particularly important source for Aristoxenus' rhythmic theory, and one whose reliability is supported by the author's parallel dependence on Aristoxenus for his treatment of harmonics. Book I is divided into sections treating harmonics (Chs. 1–12), rhythmics (Chs. 13–19), and metre (Chs. 20–29). In spite of some un-Aristoxenian elements in his approach to music,³⁰ the section on rhythm and the complementary section on metre still serve to illuminate important aspects of Aristoxenus' rhythmical systems. Admittedly, there are some clear contradictions between the two accounts of rhythmics, which justify a sceptical attitude but, in the same way as Aristides Quintilianus has used the general approach of the *Harmonics* for his own discussion while including ideas from elsewhere, it is not unlikely that he has taken the majority of his material from the rhythmic treatise while supplementing it with external (and not always consistent) material.

Also contributing to our knowledge of Aristoxenus' rhythmic theory is the fragment from *On the Primary Chronos* cited by Porphyry (78.21–79.28). In it Aristoxenus defends conceiving an infinite number of primary time units to measure rhythm dependent on the tempo of each instance. Clear comparisons can be drawn with the *Harmonics* since the author in his explanation resorts to notions similar to that of the infinitely possible positions of the pitch of moveable notes. Judging by verifiable quotations elsewhere in Porphyry, and by his generally high understanding of the subject, the relative accuracy of this citation is assured.

One further witness for rhythmic theory is presented by the fragment contained in POxy 9/2687.³¹ While not necessarily by Aristoxenus himself, the passage may depend on his theory, for it uses much of the same terminology as the *Rhythmics*³² and indicates a possible direction which Aristoxenus'

treatise may have taken. Yet its emphasis on rhythmic settings of poetry suggests that, if it is from the pen of Aristoxenus, it may belong to a treatise concerned with metre.

3. THE DIVISION OF METRE AND RHYTHM

The actual existence of Aristoxenus' rhythmic treatise in the light of the promotion of, and adherence to, a strictly limited subject matter in the *Harmonics*, suggests that Aristoxenus advocated the establishment of an independent rhythmic science and a theoretical separation between rhythm and metre. Yet any discussion on metre and its possible difference from rhythm which may have existed in this treatise or elsewhere has not survived and the only surviving evidence for a separate Aristoxenian treatment of metre lies in the way in which these topics are presented by Aristides Quintilianus. All that Aristoxenus reveals in his summary remarks at the start of Book II is that he has distinguished the rhythmic of music from the rhythmic of other domains.

Aristoxenus deliberately separates the concept of rhythm from that which is rhythmised, which enables him to treat the subject under consideration as autonomous. This separation reflects Aristotle's often repeated idea of the separation between matter and form. As in the *Harmonics*, Aristoxenus has taken a concept developed in Aristotle's writings and applied it to his own work in a way in which his teacher does not. His science of rhythmic focuses on the relationships of beats within feet, and is not necessarily dependent on a poetic text. This attitude contrasts with that of Aristotle who judges the syllable to be the unit of measure for rhythm (as he has judged the *diesis* as the unit of measure for melody), thus unequivocally cementing the domain of rhythm within language, and reinforcing the dichotomy of rhythm and melody.³³

The extended discussions offered by Aristides Quintilianus' *De Musica* on distinctions between rhythm and metre may, at least partly, have originated from Aristoxenus. Aristides Quintilianus includes separate treatments of rhythm and metre, attempting to define the difference between them. He states that there are two ways view the two subjects: firstly, that metre is part of the study of rhythm; and secondly, that the objects of rhythmic and metrics are different things. διαφέρειν δὲ τοῦ ῥυθμοῦ φασιν οἱ μὲν ὡς μέρος ὅλου (τομὴν γὰρ ῥυθμοῦ φασιν αὐτό, παρ' ὃ καὶ μέτρον εἰρήσθαι διὰ τὸ μείρειν, ὃ σημαίνει μερίζειν), οἱ δὲ κατὰ τὴν ὕλην· τῶν γὰρ γινομένων ἐκ δυεῖν ἀνομοίων τοῦλάχιστον γεννωμένων τὸν μὲν ῥυθμὸν ἐν ἄρσει καὶ θέσει τὴν οὐσίαν ἔχειν, τὸ δὲ μέτρον ἐν συλλαβαῖς καὶ τῇ τούτων ἀνομοιότητι.³⁴ Features from both sides of Aristides' division could be related to what appears to be the Aristoxenian method. As Aristoxenus divides the *rhythmizomena* into three types, those of

speech, melody and bodily movement; the section related to speech would involve some aspects of metre. The second type also seems to reflect techniques used by Aristoxenus as it separates the object rhythmised from rhythm itself, and discusses rhythmic relationships in terms of *arsis* and *thesis*. Yet its sterile approach of dividing various numbers of syllables into rhythmical patterns argues against an Aristoxenian provenance. Furthermore, earlier in the discussion on rhythm, Aristides has highlighted other aspects of these two streams of thought, and given examples of their methods. From this earlier description it is clear that Aristoxenus belongs to the first school, to those who combine the study of rhythm and metre, and not to the second, who separate them. The latter approach, as it is described by Aristides Quintilianus, appears to be as separate from musical practice as the Pythagorean ratios from melody. Aristides himself seems to favour the method of the former school as he spends a great deal more time expounding this method.³⁵

Although Aristoxenus' separation of the disciplines of music into harmonics, rhythmics and metrics is maintained by some later authors, the natural dichotomy between rhythm and melody promoted by the earlier non-specialist authors persists in the work of later, specialist authors who depend on Aristoxenus' work. In particular, the antithesis between rhythm and melody is reiterated by Aristides Quintilianus in the attribution of a masculine nature to rhythm compared to the feminine nature of melody.³⁶

In some ways the attempt to distinguish between rhythm and metre appears somewhat forced and may reflect Aristoxenus' principal concern to create an equal counterpart to the treatise on harmonics. Although the object of their respective applications can be divided between melody and verse, the forms and structures which they describe are often the same, and they both refer to the organisation of time durations. By his own division of *rhythmizomena* into speech, melody and bodily movement, Aristoxenus makes metre part of the greater topic of rhythm, the result of the imposition of rhythm onto one of three materials, rather than an independent subject.³⁷ It seems that the separate treatment of metre is justified only because it can be judged to involve more sophisticated techniques of organisation than that which can be called *rhythmopoia*. Aristoxenus' treatment suggests that whereas rhythm concerns a small and invariable unit, the foot and its internal relationships, metre gathers more sophisticated, and varying patterns embodied in verse.

4. THE ABSENT BOOK I

The fragment of the *Rhythmics*, despite its brevity, shows many methodological similarities to the *Harmonics* which Aristoxenus is conscious and willing to emphasise through the continual references to harmonic theory. Yet, unlike

his harmonic science, Aristoxenus does not seem to have formed his theories against the background of previous scholarship, and consequently there is an absence of criticism against predecessors. There is no sense that Aristoxenus is establishing an innovative science against the tide of popular—Pythagorean or sophistic—opinion, rather he seems to have formed his theories as a complement to his own harmonic treatise.

It is difficult to get a sense of the formal structure of the treatise on rhythm since its remains are so short. However, in the light of the conceptual similarity of Aristoxenus' approach to his two technical musical subjects, the possibility of the *Rhythmics* following a similar structure to the harmonic treatise can be considered with a view to restoring the contents of the missing Book I. Helpfully, Aristoxenus' comments in the opening paragraphs of Book II refer to some of the contents of the previous section. It is unsurprising that his remarks indicate that it was concerned with defining the subject and its scope. A few specific topics are mentioned in the first paragraph: ὅτι μὲν τοῦ ῥυθμοῦ πλείους εἰσὶ φύσεις καὶ ποία τις αὐτῶν ἐκάστη καὶ διὰ τίνας αἰτίας τῆς αὐτῆς ἔτυχον προσηγορίας καὶ τί αὐτῶν ἐκάστη ὑπόκειται, ἐν τοῖς ἔμπροσθεν εἰρημένον. νῦν δὲ ἡμῖν περὶ αὐτοῦ λεκτέον τοῦ ἐν μουσικῇ ταττομένου ῥυθμοῦ.³⁸

The reference to descriptions of “many kinds of rhythm, and what each of them is like” recalls the method used in the harmonics highlighted in our previous chapter. This method of “how many and of what kind” (πόσα τ' ἐστὶ καὶ ποῖ ἅττα) is used in order to divide the subject into clearly defined parts. In this case, Aristoxenus divides rhythm into several types and then separates musical rhythm from the rest. The types of rhythm to which he refers may be recoverable from Aristides Quintilianus (31.3–7) who states that the term rhythm is used in three ways: to apply to bodies which do not move (e.g. statues), to apply to anything which does move (e.g. someone walking), and to the specific subject of sound (i.e. that with which the discussion is concerned). Another, older, use of the word appears in Aristotle who uses the term “rhythm” along with inter-contact and turning (διαθιγή and τροπή) to refer to the way that differences between elementary particulars were described by anatomists Leucippus and Democritus.³⁹ With these examples it is possible to see the ways in which “rhythm” can be applied outside the sphere of sound and time.

This separation of musical rhythm from other kinds of rhythm is analogous to the discussion in Book I of the *Harmonics* on the movement of the voice (8.13–15.13). In that elementary discussion continuous and intervallic movements of the voice were separated from one another and the type of movement irrelevant to music (continuous) was omitted from the following

discussion. Correspondingly, this reference to the discussion of different kinds of rhythm actually would argue against excluding the elementary section on the movement of the voice from the *Harmonics*.⁴⁰ On the other hand, Aristoxenus' distinction between types of rhythm may have been drawing a distinction between *eurhythmic* and *arrhythmic* sound or between some other characteristics. On such slight evidence it is difficult to draw firm conclusions.

The second paragraph claims to repeat from the previous discussion the concerns of rhythmic science: ὅτι μὲν οὖν περὶ τοὺς χρόνους ἐστὶ καὶ τὴν τούτων αἴσθησιν.⁴¹ The emphasis on the role of the senses recalls the central methodological concern of the harmonic treatise: how melodic structures are perceived is considered by Aristoxenus to be more important than the mathematical ratios of intervals. This initial definition of rhythm referring to duration is said to be somehow the first principle of rhythmic study, ἀρχὴ γὰρ τρόπον τινὰ τῆς περὶ τοὺς ῥυθμούς ἐπιστήμης ἐστὶν αὕτη (2), and again the terminology recalls the language of the *Harmonics*.

Can the fragment from Book II be placed in the context of a general treatise plan along the lines of the *Harmonics*? This would suggest a structure which includes: an introduction and definition of the subject; a list of the parts of the subject; a more extended discussion of those parts; and an axiomatic-style section of theses describing the possible arrangement of rhythmical space. Some of this outline can be seen in the fragment itself or in the supplementary sources. The definition of the subject is provided by the second paragraph of our fragment. The list of parts does not appear here but may be supplied by the treatise of Aristides Quintilianus. Aristides organises his science into five parts: primary durations, the genera of feet, rhythmical tempo, modulation and rhythmic composition (πρῶτοι χρόνοι, γένη ποδικῶν, ἀγωγή ῥυθμική, μεταβολή, ῥυθμοποιία, 32.8–10). It is not improbable that Aristoxenus conceived such a division of the subject, considering the similarity of this list to that of the parts of harmonics, which is the same in both authors: genera, intervals, notes, *systemata*, *tonoi*, modulation and melodic composition.⁴² While there is no evidence of the systematic organisation of the *Rhythmics* into the parts indicated by Aristides, the existing section does treat many aspects of this material.

What we do have in the fragment is the extended discussion of concepts, and lists of rhythmic structures. The fact that criticism of predecessors, which formed such a significant part of the exposition of the *Harmonics*, makes no appearance in the surviving material, can be attributed to the fragment starting with Book II, or possibly to the lack of earlier work in the field. Finally, although the treatise appears to be moving towards describing rhythmical

structures when it breaks off, there is no real indication of ambition towards an axiomatic conclusion to the treatise.

Therefore, although we have some indications of the contents of Book I, we cannot defend any detailed conclusions about the structure of the treatise as a whole, nor can we assume its conformity to the organisation of the *Harmonics*.⁴³ Let us return to analysis of what we have rather than speculation about what we have not.

5. BOOK II

Following on from the summary of Book I or at least “of our preceding discussion” is the introduction and treatment of the terms and subjects related to the science. There are four principal surviving subjects, including *rhythmizomena* (3–9), *chronos protos* (10–12), *rhythmopoia* (13–15), and the foot (16 ff.). This exposition of terms and definitions is combined with conceptual discussions about the nature of musical rhythm. The end of the fragment contains an enumeration and explanation of the differences between feet (22–29), a list of genera (30), and finally a list of feet in order of length (31–36). Two subjects whose treatments do not survive in the *Rhythmics* but are mentioned by Aristides are *agoge* (tempo) and modulation. *Agoge* is briefly mentioned by Aristoxenus in Porphyry’s citation of *On the Primary Chronos*, but only to state that there is an infinite number of tempi possible for each rhythm (78.23 and 79.17). There is nothing remaining on Aristoxenus’ discussion of modulation but Aristides Quintilianus describes it as a *ῥυθμῶν ἀλλοίωσις ἢ ἀγωγῆς*, an “alteration of rhythm or of tempo” (40.1–2), and lists ways in which this may happen.⁴⁴ There is no reason not to think that these subjects were treated in some now-missing part of Aristoxenus’ exposition.

5a. *Rhythmizomena*

After defining rhythm as being concerned with durations, the first notion introduced is that of the *rhythmizomenon*, and Aristoxenus includes extensive explanatory material about it (3–9). In the first place, he states that *rhythmizomenon* must be distinguished from rhythm. His explanation, which refers to the difference between shape and what is shaped (τὸ σχῆμα καὶ τὸ σχηματιζόμενον, 3), depends on Aristotle’s division between form and matter.⁴⁵ The importance of not identifying the rhythm with the rhythmised substance is repeated several times, and in particular Aristoxenus notes that rhythm and shape do not exist in isolation but depend on a medium (6). Furthermore, it is important to note that *rhythmizomena* does not refer to melody,

speech/verse or dance themselves, but to the parts which make up these things, i.e. notes, syllables, poses.

As we have noted above, earlier discussions of rhythm such as those by Plato and Aristotle, often presumed this medium to be language, but Aristoxenus attempts to establish the independent status of *rhythmizomena*. While he refers specifically to speech as an example of *rhythmizomenon*, he balances it with a reference to melody and to any medium capable of being rhythmised. The mention of speech as an example of a material capable of accepting rhythm leads to an insight into the possible contents of the remainder of the treatise. ἡ γὰρ αὐτὴ λέξις εἰς χρόνους τεθεῖσα διαφέροντας ἀλλήλων λαμβάνει τινὰς διαφορὰς τοιαύτας, αἱ εἰσιν ἴσαι αὐταῖς ταῖς τοῦ ῥυθμοῦ φύσεως διαφοραῖς.⁴⁶ Manipulation of the sort indicated is exemplified in the treatise preserved by P. Oxy 9/2687.⁴⁷ It concerns the possible rhythmic settings of a particular *lexis* of five beats (---) and the ways in which it could be extended to six beats. This is achieved through the lengthening of one of the long syllables to three times the fundamental unit (rather than twice) while maintaining the rhythmic effect and not violating the natural syllable lengths.

Aristoxenus makes use of the concepts which he had developed for his harmonic treatise. One opportunity for this occurs in relation to arrangement of *chronoi* (durations) when Aristoxenus states that rhythm arises ὅταν ἡ τῶν χρόνων διαίρεσις τάξιν τινὰ λάβῃ ἀφωρισμένην, οὐ γὰρ πᾶσα χρόνων τάξις εὐρυθμος.⁴⁸ However, a *rhythmizomenon* is capable of accepting arrangements of *chronoi* which are *arrhythmic* as well as those which are *eurythmic* (7 and 8). Here Aristoxenus makes two analogies, the first to arrangements of letters, and the second to musical intervals. ἔστι δὲ ἡμῖν γνῶριμα τὰ περὶ τὴν τῶν γραμμάτων σύνθεσιν καὶ τὰ περὶ <τὴν> τῶν διαστημάτων, ὅτι οὐτ' ἐν τῷ διαλέγεσθαι πάντα τρόπον τὰ γράμματα συντίθεμεν, οὐτ' ἐν τῷ μελωδεῖν τὰ διαστήματα.⁴⁹ Both analogies reflect passages from the *Harmonics*. The analogy of letters, mentioned only briefly here appears in both books of the *Harmonics* at 27.18 and 37.2. The reference to the order of notes reflects the extended analysis of continuity and succession which closes the first two books of the *Harmonics* and is the primary subject of the third. The present passage goes on to remind the audience that there are many more unacceptable than acceptable forms of melody and rhythm and that the judgement of the senses will indicate those which are alien.

Finally, although he has already referred to speech and melody Aristoxenus specifies that there are three kinds of *rhythmizomena* in relation to music: the parts of speech (λέξις), melody (μέλος) and bodily movement

(κίνησις σωματική) (9). The passage presenting this material shows a lack of linguistic discernment on Aristoxenus' part. The parts dividing speech (letters, syllables and words) and those dividing dance (signs and figures), are unproblematic. However, for melody, Aristoxenus uses terms more at home in harmonic analysis without clarifying their meaning in this context: notes, intervals and *systemata*. It is possible that, after having written his ground-breaking treatise on harmonics, Aristoxenus has unthinkingly labelled the division of melody according to the structures of harmonic science, without adjusting his terms to represent a rhythmic, linear progression, organising time rather than pitch space. On the other hand, it is also possible that by the term "intervals" Aristoxenus intended to convey two different notes to be played one after another, at an interval of time as well as of pitch, and by "*systemata*" a consecutive series of notes in a melody, but this seems unlikely.

While Aristoxenus attempts to abstract rhythm from *rhythmizomenon*, he takes care to set out the types of substance on which can be imposed rhythmic arrangement of durations. His description of rhythm is therefore not entirely abstracted from musical examples, it is merely not dependent on a single medium. It does however emphasise the break from earlier treatments in rejecting the assumed association of rhythm and metre.

5b. *The chronos protos*

According to Psellus, Aristoxenus rejects the syllable as the unit of measure for rhythm.⁵⁰ In its place he introduces the notion of the *πρώτος χρόνος*, the second part of rhythemics treated (10–12). The *πρώτος χρόνος* represents a unit of measure for rhythm, of which all other durations involved in that example of rhythm are multiples: καλείσθω δὲ πρῶτος μὲν τῶν χρόνων ὁ ὑπὸ μηδενὸς τῶν ῥυθμιζομένων δυνατὸς ὧν διαιρεθῆναι, δίσσημος δὲ ὁ δις τοῦτο καταμετρούμενος, τρίσημος δὲ ὁ τρίς, τετράσημος δὲ ὁ τετράκις.⁵¹

Yet the reason for the rejection presented by Psellus is not related to its poetic associations, rather to its inconsistent length. ὁ δὲ γὰρ Ἀριστόξενος, οὐκ ἔστι, φησὶ, μέτρον ἢ συλλαβή. πᾶν γὰρ μέτρον αὐτό τε ὠρισμένον ἐστὶ κατὰ τὸ ποσὸν καὶ πρὸς τὸ μετρούμενον ὠρισμένως ἔχει.⁵² Psellus' justification can only be based on the assumption that he is referring to long as well as short syllables. If he is merely referring to the fluctuations of tempo, his arguments can be equally applied to the *chronos protos*. Indeed, Aristoxenus has already asserted that the syllable is one of the three markers of measurement in rhythm along with notes in melody and the signs in bodily movement (9). Therefore, his motivation for rejecting the syllable, if in fact he can be said to have done so, must have been to establish terminology

for a generic unit of measure abstracted from the associations of any particular instance of musical sound.

The rhythmic concept of the *protos chronos* has already been raised by Aristoxenus in the *Harmonics*. In the introductory section of Book II, notions of constancy and change are discussed in relation to music “as a whole and all its parts” διὰ πάσης καὶ κατὰ πᾶν μέρος αὐτῆς (33.31), referring to examples from rhythmic as well as melodic structures. Aristoxenus cites, among other things, the stability of the bounding notes of a tetrachord compared with the variability of the moveable notes and the corresponding change of genera. In the same passage, now in relation to rhythmics, he observes the possibility of complex variations in rhythmic composition with the use of certain fixed structures: καὶ γὰρ μένοντος τοῦ λόγου, καθ’ ὃν διώριστα τὰ γένη, τὰ μεγέθη κινεῖται τῶν ποδῶν διὰ τὴν τῆς ἀγωγῆς δύναμιν, καὶ τῶν μεγεθῶν μενόντων ἀνόμοιοι γίνονται οἱ πόδες· καὶ τὸ αὐτὸ μέγεθος πόδα τε δύναται καὶ συζυγίαν· δῆλον δ’ ὅτι καὶ αἱ τῶν διαιρέσεων τε καὶ σχημάτων <διαφοραὶ> περὶ μένον τι μέγεθος γίνονται. καθόλου δ’ εἰπεῖν ἢ μὲν ῥυθμοποιία πολλὰς καὶ παντοδαπὰς κινήσεις κινεῖται, οἱ δὲ πόδες οἷς σημαίνόμεθα τοὺς ῥυθμοὺς ἀπλᾶς τε καὶ τὰς αὐτὰς αἰεὶ.⁵³

Similarly in the *Rhythmics* itself the signals of the foot are said to remain constant while the *rhythmopoia* provides variation: νοητέον δὲ χωρὶς τὰ τε τὴν τοῦ ποδὸς δύναμιν φυλάσσοντα σημεῖα καὶ τὰς ὑπὸ τῆς ῥυθμοποιίας γινομένης διαιρέσεις.⁵⁴ Just as the possibility of infinite compositional variation in rhythm contrasts with the use of a consistently structured foot, the flexibility of the *protos chronos* according to the tempo of the rhythm contrasts with the constancy of its relationship to other durations. The similarity to the passage cited above indicates that Aristoxenus had at least conceived the substance of his rhythmic theory when he wrote the second book of the *Harmonics*. The comments appear to be at an almost equivalent stage of conceptual development, with those appearing in the *Harmonics* perhaps written slightly earlier. In that passage Aristoxenus refers clearly to the concept of the *chronos protos* but has not clarified his terminology, referring rather vaguely to μέγεθος (34.17).

Aristoxenus may have had some confused or negative response to his presentation of the idea of the *protos chronos* since he gives further explanation of it in the work *On the Primary Chronos*, quoted at length by Porphyry. In the revision, the tempo (ἀγωγή) of a rhythm is clearly associated with its *protos chronos*: ὅτι δ’ εἴπερ εἰσὶν ἑκάστου τῶν ῥυθμῶν ἀγωγὰ ἄπειροι, ἄπειροι ἔσονται καὶ οἱ πρῶτοι, φανερόν ἐκ τῶν ἔμπροσθεν εἰρημένων.⁵⁵ He asserts that the involvement of an infinite measurement

does not undermine the certainty of the science of rhythm, and attempts to clarify this claim: οὔτε γὰρ πόδας συντίθεμεν ἐκ χρόνων ἀπείρων, ἀλλ' ἐξ ὠρισμένων καὶ πεπερασμένων μεγέθει τε καὶ ἀριθμῷ καὶ τῇ πρὸς ἀλλήλους ἑξυμετρίᾳ τε καὶ τάξει.⁵⁶ In order to reiterate this concept, Aristoxenus presents an analogy from the *Harmonics*⁵⁷ as he reminds the audience that although there are infinite possible positions for the pitch of a moveable note, in any particular scale or melody there will only be one actual pitch for that note. Similarly, in any example of rhythm, although there is infinite potential for the length of the duration of the primary *chronos*, there will be only one actual length.

In summary, apart from the division between metre and rhythm, Aristoxenus also develops independent ideas about measurement in rhythmic theory. The *chronos protos* provides a term for a unit of measurement which has no particular association to melody, poetry or dance. It establishes an atomic element from which rhythm can be built, functioning in a similar way as the *diesis* in some methods of harmonic theory. The difference, of course, is that the *diesis* is generally assumed to be (at least approximately) a quarter-tone, whereas the *protos chronos* has no standard measure and varies infinitely according to the tempo of the rhythm.

5c. *Rhythmopoia*

The section on ῥυθμοποιία (13–15) is not a manual on compositional techniques but is almost entirely concerned with making a distinction between an instance of rhythmic composition and rhythm itself. This offers more opportunity for Aristoxenus to make comparisons with the subject of harmonics, and accordingly he highlights the parallel between the relationship of *rhythmopoia* to rhythm, and that of *melopoia* to *melos*.⁵⁸

In this section Aristoxenus presents a distinction between composite and non-composite time lengths which only has significance in the context of rhythmic composition. This refers to whether a *chronos* is occupied by one syllable, note, or signal (non-composite, ἀσύνθετος) or by more than one (composite, σύνθετος). Unsurprisingly, Aristoxenus again uses harmonics to clarify the point and presents as an example the semitone which is a composite interval in the enharmonic genus, but a non-composite one in the chromatic and diatonic genera. The point is further expanded with the presentation of the possibility that a mixed (μικτός) *chronos* may be composite at one moment in a composition and non-composite at another. He shows an awareness of the subtle differences presented by his analogy in distinguishing between the status of the (non-) composite unit created by the structure of the scale, and that created by the whims of composition.

5d. The Foot

Following on from *rhythmopoia* is the discussion of feet (16–29): ὥι δὲ σημαίνόμεθα τὸν ῥυθμὸν καὶ γνῶριμον ποιοῦμεν τῇ αἰσθήσει, πούς ἐστιν εἷς ἢ πλείους ἑνός.⁵⁹ This definition highlights the role of perception in understanding rhythmic structures, and it is later explained that the shorter feet are easier to comprehend (18). Aristoxenus states that a foot consists of two *chronoi* (one beat up, one down), three (two up, one down and vice versa), or—with the textual emendation undertaken by most editors—four *chronoi*, (two up and two down, 17).⁶⁰

Some terminology should be clarified here. ‘*Chronos*’ refers to the non-composite *chronos* rather than to the *chronos protos* and is distinct from the term σημεῖον. The *protos chronos* as a fixed unit within a composition is distinct from the *chronos* as a single *rhythmizomenon* which can vary in length (such as in the difference between short and long syllables). A σημεῖον is a sign to indicate duration in relation to the primary *chronos*. It is also fixed, but multiple *semeia* may have different amounts of *chronoi* according to the rhythmic realisation. For example, in his enumeration of feet (31 ff.) Aristoxenus claims that the smallest length of foot is of three units (τρίσημος): τὸ γὰρ δίσημον μέγεθος παντελῶς ἂν ἔχοι πυκνὴν τὴν ποδικὴν σημασίαν.⁶¹ Therefore, the *chronos* must refer to any non-composite *chronos* regardless of length because only in this way can an iambic or trochaic foot be described as of three units but two *chronoi*. Furthermore, the original definition of the *chronos protos* named the diseme, triseme and tetraseme, as multiples of itself thereby indicating that the suffix—σημος is equivalent to *chronos protos*.

The differences between feet listed in this section are parallel to the exposition of the intervals and of the *systemata* in Book II of the *Harmonics*. Both of these are accompanied by a similar list of differences. For the foot there are seven: *megethos* (length), genus, whether it is rational, whether it is composite, *diairesis* (division), *schema* (arrangement), *antithesis* (the reversal of the positions of *arsis* and *thesis*). Following these distinctions is a list of the three genera: dactylic, of equal ratio (2:2), iambic, of double ratio (2:1), and paeonic, of hemiolioic ratio (3:2). τῶν δὲ ποδῶν <τῶν> καὶ συνεχῇ ῥυθμοποιίαν δεχομένων τρία γένη ἐστί· τό τε δακτυλικὸν καὶ τὸ ἱαμβικὸν καὶ τὸ παιωνικόν.⁶² It should be noted that the terms Aristoxenus uses to name the genera are not restricted to their metrical definitions. The dactylic genus does not refer only to the dactylic foot (~~~), but to any foot of equal ratio. In his list of feet, Aristoxenus includes as dactylic feet of six and eight *semeia*. The same is true for the iambic genus.

The final section of our fragment is an enumeration of feet in order of length. The shortest of these is of three *semeia* and the treatise ends abruptly at

eight *semeia*.⁶³ Aristoxenus designates certain arrangements of feet as not rhythmical (οὐκ ἔνρυθμος). In the foot of four *semeia* for example, he tells us that only the 2:2 ratio is acceptable, whilst 3:1 is not. Likewise, Aristoxenus rejects the ratios of 4:1 and 5:1. The seven-signal foot is rejected outright in all its forms (4:3, 5:2 and 6:1) and the eight-signal foot can only be arranged as a dactylic foot (4:4) which Aristoxenus is about to explain, when the treatise is cut off. While Aristoxenus has already limited the paeonic foot, of five *semeia*, to an arrangement of 3:2 or 2:3, the restriction to feet of four *chronoi*, noted at the start of the section, has further implications for this foot. It means that there must be at least one long syllable in any realisation of this foot, and in any foot longer than four units.

Although Aristoxenus has specifically rejected certain ratios as not rhythmical, there is doubt about the status of irrational feet and rhythms in rhythmic composition. Aristoxenus goes into some detail in his description of rhythms which are not *alogs*; within the foot it depends on having a rational relationship between the *arsis* and the *thesis*. Yet he spends some time describing a foot called the irrational *choreios* (a synonym for trochee~) which has an irrational relationship between the *arsis* and *thesis* of between 2:2 and 2:1. It might be supposed that Aristoxenus is not genuinely condoning the use of such a foot in rhythmic composition, and considers it the result of careless performance; this latter possibility is raised by the *Fragmenta Neapolitana*, a work which mentions a quasi-rhythmic *chronos* occurring in rhythms which are imprecise in observing the relationships of *chronoi* to one another (11, 413.17–414.7). But this is very unlikely. There would be no reason, on that hypothesis, for Aristoxenus to single out the ‘irrational *choreios*’ for special mention and analysis, to specify in *Rhythmics* 22 the distinction between rational and irrational as marking one of the significant differences between feet, or to define irrationality as he does in 25.

Furthermore, Aristoxenus’ definition of feet which differ in *diairesis* refers to ὅταν τὸ αὐτὸ μέγεθος εἰς ἄνισα μέρη διαιρεθῇ, ἥτοι κατὰ ἀμφοτέρω, κατὰ τε τὸν ἀριθμὸν καὶ κατὰ τὰ μεγέθη, ἢ κατὰ θᾶτερα.⁶⁴ This distinction raises many questions for which there are no satisfactory answers. One of the possibilities presented is the case of two feet of the same magnitude, with the parts of one foot equal in number but unequal in magnitude to those of the other. Does Aristoxenus accept that a spondee (- -) could be used next to an iamb (~-) while maintaining a constant magnitude of foot (and therefore a constant ictus as the demands of dance would suggest)?⁶⁵ Aristoxenus does not clarify whether such feet can be used together in the same *rhythmopoia* or whether this would bring about rhythmic modulation.

The solution is not presented when Aristoxenus discusses irrational time-lengths, even though he distinguishes between those which can be used in composition and those which are only used in analysis. To this distinction he compares the interval of the twelfth-tone, useful as a distinction between a third- and a quarter-tone, but not possible to use in practice. τὸ μὲν οὖν ἐν ῥυθμῷ λαμβανόμενον ῥητὸν χρόνου μέγεθος πρῶτον μὲν δεῖ τῶν πιπτόντων εἰς τὴν ῥυθμοποιίαν εἶναι, ἔπειτα τοῦ ποδὸς ἐν ᾧ τέτακται μέρος εἶναι ῥητόν.⁶⁶ Yet he does not state precisely whether the reverse of this statement holds true, that in order to be appropriate to *rhythmopoia* a time-length must be rational. Nevertheless, the passage does suggest, despite the careful attention he gives to the irrational *choreios*, that Aristoxenus would reject irrational time-lengths.

Perhaps the definition of the genera can furnish a possible solution (30). These three basic forms of feet (dactylic, iambic and paemonic) are said to be the kinds of feet which can accept συνεχῆς ῥυθμοποιία. The inclusion of the adjective “sustained” or “continuous” may indicate that irrational feet can be substituted occasionally as variation within a generally regular rhythm. Psellus uses similar languages when he calls these standard ratios “most natural,” εὐφυέστατοι (9). The *Fragmenta Neapolitana* also refer to rhythms capable of admitting a continuous *rhythmopoia*: οἱ ῥυθμοὶ οἱ δυνάμενοι συνεχῇ ῥυθμοποιίαν ἐπιδέξασθαι (13, 414.11–15). However, as Aristoxenus has rejected the 4:3 foot as not rhythmical, it is unlikely that he would accept any truly irrational foot.

5e. The Role of Perception

As we have seen, Aristoxenus defines rhythm as being concerned with time lengths and the perception of them (2). Concern for the importance of perception is raised repeatedly throughout the rhythmic fragment (at 5, 8, 11, 12, 16, 18, 20, 21) imitating the methodological emphasis of the *Harmonics*. Yet, like the division of metrics and rhythmics, the role of perception in rhythmic theory is a little forced. While the opposition of reason and perception is central to harmonic theory because their results are contradictory,⁶⁷ the role of perception in rhythmic theory is much reduced.

Reference to sense perception occurs in various instances: firstly, it is applied to the understanding of the separation of rhythm and rhythmised substance (5); secondly, when Aristoxenus discusses acceptable arrangements of melody and rhythm, he notes that some appear alien to perception (ἀλλότριά φαίνονται τῆς αἰσθήσεως οὖσαι, 8). In neither case does this lead Aristoxenus to insist on a certain methodology for rhythmic analysis. Because he defines rhythm through numerical ratio, there is no contradiction

(as far as we know) with any other method of analysing rhythm.⁶⁸ The distinction between Pythagorean and Aristoxenian harmonic methods depends on his rejection of the ratio as the criterion for analysing pitch relationships. There is no equivalent problem in rhythmic theory, and even if there were another system of analysis, it is likely that a method which rejected sense perception in rhythmic analysis would depend on rational representation of rhythm.

The closest that Aristoxenus' use of perception in rhythmic comes to that in harmonics concerns rational and irrational rhythms, as he distinguishes two types of rationality: τὸ μὲν γὰρ κατὰ τὴν τοῦ ῥυθμοῦ φύσιν λαμβάνεται ῥητόν, τὸ δὲ κατὰ τοὺς τῶν ἀριθμῶν μόνον λόγους.⁶⁹ But here the criterion for recognising rationality is a cut-off point beyond which the numbers in the ratio are too high to comprehend. It is a matter of quantity, not quality and not dissimilar to the Pythagorean conception of harmonic consonance which only included ratios containing the numbers one to four. Unlike his total rejection of numerical ratios as a basis for harmonic science, Aristoxenus accepts quantitative relationships of rhythmic in ratio form and does not suggest the dynamic relationships such as those emphasised in his *Harmonics* at the expense of ratio-based terminology. After the conceptual discussions of rhythm are over, there is a clear emphasis on the quantitative elements of rhythm, which undermines the attempt to use perception as a principal method of describing rhythmic.

CONCLUSION

The references in the *Rhythmics* to the science of harmonics, with clear recollection of methods used in the harmonic treatise of Aristoxenus, indicate that it was written after that innovative work. Equally, the more concise language and clearer organisation in the rhythmic treatise suggests a later work, with the ideas developed for the *Harmonics* now applied to a related subject. Yet, since the second book of the *Harmonics* refers to concepts treated in the *Rhythmics* and there is no reference to rhythm in the first book of the *Harmonics*, it is conceivable that the *Rhythmics* was written between the two first books of that treatise, or at least was in preparation. However, clear references in the *Rhythmics* such as ὥσπερ γὰρ ἐν τῇ τοῦ μέλους φύσει τεθεωρήκαμεν⁷⁰ suggest that also the second book of the *Harmonics* has already been composed or at least delivered as lectures. Furthermore, since Aristoxenus refers clearly to a discussion on melodic composition (13), the *Rhythmics* must have been produced after Book II of the *Harmonics*, as composition is specifically rejected from Book I. It is clear then, that Aristoxenus had devoted some time to formulating theories about rhythm before he had finished his earlier treatise. The citation by Porphyry of

Aristoxenus' discussion of the *chronos protos* probably belongs to a later treatise than the *Rhythmics*. Just as problems in the first book of the *Harmonics* encouraged its revision, the difficulties presented by the concept of the *chronos protos* in the *Rhythmics* seem to have prompted Aristoxenus to further clarification.

We have seen that the divisive organisational systems employed in the *Rhythmics* are analogous to those in the *Harmonics*. This is anticipated on a most general level in the *Harmonics* with the division of music into separate sciences. Within the rhythmic treatise, Aristoxenus defines rhythm in general (Book I) and then distinguishes from this one sort of rhythm, that in melody. It is possible—taking into account the evidence from Aristides Quintilianus—that Aristoxenus clarified the division of rhythmics with a list of specific parts, but no such list survives in the *Rhythmics*. However, the subject matter of the text is loosely separated into four main sections dictated by the introduction and explanation of technical terminology. As far as we can tell from the fragment, the treatise differs from the *Harmonics* in its preference for definitions of particular terms over methodological analysis.

While Aristoxenus has constructed the techniques of his harmonic treatise against previous scholarship in the field, both the lack of an established tradition of rhythmic theory and the apparent desire to establish a counterpart to his earlier treatise tempt Aristoxenus to carry over many aspects of the methodology into the *Rhythmics*. In some ways this transfer is successful; by using the notion of a particular measurement chosen from a theoretically infinite number, he establishes a flexible *chronos protos* as a unit of measure which is theoretically abstract from the associations of any particular musical form. Similarly, his enumeration of the differences between feet imitates the distinctions between intervals and *systemata* presented in the *Harmonics*. Yet limitations of the methodology of the *Harmonics* when applied to the subject of rhythm are apparent. The difficulty of establishing a separate science from metrics limits the success of this treatise, and the emphasis on perception is slightly misplaced, as the contradictory results of perception and reason are not an important issue.

The similarity in the accounts of rhythmics and harmonics suggests some subjective manipulation, and a contrived organisation, rather than an objective account. Furthermore, Aristoxenus' attempt to describe the most fundamental aspects of rhythmic theory may have led him to overlook the subtle variation evident in the complex metres of Greek verse.⁷¹ In addition, the uncertain status of *alogos* rhythm further separates this treatise from rhythmic practice, although admittedly Aristoxenus does not claim to describe trends in music performance.

Despite its limitations, Aristoxenus' *Rhythmics* presents a subtle description of rhythm. The separation of rhythm from *rhythmizomenon* and the establishment of the *chronos protos* as an independent unit of measurement are essential to achieving Aristoxenus' aim of creating rhythmics as an independent science. Unfortunately, the fragmentary nature of the direct evidence, and uncertainties about the Aristoxenian status of material transmitted by later writers, do not help us to judge further his treatise or the nature of the subject matter contained in the missing text.

Aristoxenus' musical theory, as it appears in the *Harmonics* and the *Rhythmics*, forms the majority of his surviving work. It demonstrates Aristoxenus' remarkable, but not infallible, capability to develop innovative methodologies to describe the structures of musical phenomena while remaining independent from other sciences.

Not the *Harmonics*

INTRODUCTION

Having looked at the methodological techniques employed by Aristoxenus in the groundbreaking theoretical works which formed the basis of his reputation as ὁ μουσικός in antiquity, it is time to examine the remaining fragments of his writings on music.¹ Aristoxenus' development of revolutionary methods for analysing musical structures leads us to ask whether there is evidence for comparable innovation by him in other areas of musical scholarship. The simple answer is no, as the self-conscious sense of creating a new musical science which we find in the *Harmonics* is lacking in what remains of his more general works. On the other hand, while the *Harmonics* presents the thought of a learned but pedantic, technically focused, and topically restricted scholar whose importance outside the narrow field of ancient Greek musical theory is limited, the fragments on music demonstrate without a doubt his flexibility as an author and his ability to apply an encyclopaedic knowledge of the subject with a broad philosophical perspective.

There are references in the fragments to an extensive range of musical subjects treated by Aristoxenus, including instruments, dance, melody, tragedy, education, performance and history. It becomes apparent from these tantalising remains that Aristoxenus' main surviving work, the *Harmonics*, does not give the full picture of his impressive musical knowledge. This is shown in the variety of subjects he treats under the general category of music and attested in the titles of his works, as well as in the scraps of information which cannot be attributed to any known text. In addition, the fragments provide evidence of a considerable amount of work outside the field of music. Indeed, the *Suda* informs us that Aristoxenus compiled works on music, philosophy, history, and education of every form, totalling 453 books.²

What can be gleaned about Aristoxenus' general musical writings suggests that they were subject to methodological influences different from those affecting the *Harmonics*. In Chapters One and Two we noted Aristoxenus' reaction against the methods of Pythagoreans and *harmonikoi*, as well as his attempt in the *Harmonics* to create a science conforming to the Aristotelian model of an axiomatic-deductive science as it is set out in the *Posterior Analytics*. The *Harmonics* shows the author's particular awareness that he is forging a new approach to this subject and that he is eager to distance himself from earlier efforts. The methodology established for the harmonic treatise was then applied to the *Rhythmics*. On the other hand, the fragmentary remains of Aristoxenus' other works show different aspects of Aristotelian influence and the relatively greater significance of his early Pythagorean training.

Although he employs a methodology adopted from the *Posterior Analytics* in the harmonic treatise, Aristoxenus' tacit disagreement with his master over the status of harmonics as an independent science obscures the depth of his commitment to Aristotle's teaching. In the fragments, on the other hand, axiomatic-deductive ambition is passed over in favour of a methodology recognisably akin to that more generally promoted by the Peripatetic school, with an emphasis on the collection of material across a broad field, and its cataloguing and classification.³ This cumulative approach to science acknowledges the work of earlier philosophers as well as of the author's contemporaries.⁴ It is able freely to incorporate discussion of the sociological significance of the subject in addition to its history and development (rather than merely criticism of rivals or predecessors). Such aspects of scholarship are only hinted at or completely ignored in the *Harmonics*.

Furthermore, there is evidence of Pythagorean and Platonic influences on Aristoxenus' work. While this may seem surprising in the light of Aristoxenus' flat rejection of the Pythagorean ratio calculations of intervals in relation to harmonic science, one must remember that Aristoxenus does not criticise the Pythagoreans per se, but merely disregards this technique as irrelevant to his own understanding of the subject. In matters concerning the sociological function of music, Aristoxenus often adheres to ideas promoted by Pythagorean writers and by Plato. This is particularly apparent in his writings concerning the doctrine of ethos and the role of music in education.

The fragments nevertheless demonstrate Aristoxenus' continuing concern for systematic and careful research, and his emphasis on defining the limits of a subject. What is also notable in the effects of various philosophical influences is the way in which Aristoxenus adopts certain styles and techniques according to his subject. He takes a far less revolutionary approach in his non-technical musical writings and incorporates the opinions

and methods of other scholars. This suggests that although the *Harmonics* may be Aristoxenus' most original and finest work, it may not be representative of his general philosophical output.

1. TITLES AND SOURCES

Several lost works by Aristoxenus are explicitly named within the fragments collected by Wehrli. Those on music include the general treatise *Περὶ μουσικῆς* in at least four books.⁵ On musical instruments and performance there are a range of titles: *Περὶ αὐλῶν τρήσεως* in more than one book,⁶ *Περὶ αὐλητῶν*,⁷ *Περὶ ὀργάνων*,⁸ *Περὶ αὐλῶν καὶ ὀργάνων*,⁹ *Περὶ τραγικῆς ὀρχήσεως*,¹⁰ and *Περὶ τραγωδοποιῶν* in more than one book.¹¹ The titles of musical theoretical works include the *Περὶ τῆς μουσικῆς ἀκροάσεως*,¹² *Περὶ μελοποιίας* in at least four books,¹³ as well as the titles not included by Wehrli in his collection: *Περὶ τοῦ πρώτου χρόνου*¹⁴ and *Περὶ τόνων*.¹⁵ Fragments from other works cited include references to musical material, but may not be essentially musical writings. These include the *Συγκρίσεις*,¹⁶ *Σύμμικτα ὑπομνημάτα*,¹⁷ *ἐν δὲ τοῖς κατὰ βραχὺ ὑπομνήμασιν*¹⁸ and perhaps also the *Πραξιδαμάντεια*.¹⁹ The greater portion of the fragments referring to music is not attributed to any particular one of these, but in some cases can be tentatively connected to certain titles from the subject matter or from similarities to specifically cited works.

The references to some of these titles are rather fleeting, and it is possible that they are slightly inaccurate. Such similar titles as *Περὶ αὐλῶν καὶ ὀργάνων* and *Περὶ ὀργάνων* probably refer to the same work. Equally, some may belong together as chapters of a single work; *Περὶ αὐλῶν τρήσεως* and *Περὶ αὐλῶν καὶ ὀργάνων* and *Περὶ αὐλητῶν* may all be parts of the same *Περὶ ὀργάνων*. Finally, of course, the *Περὶ μουσικῆς* may have included some of the other titles as chapters.

The fragments themselves come from a range of sources, the most rewarding of which is the *De Musica* of Ps.-Plutarch (first or second century CE). This work provides most of the surviving material from Aristoxenus' non-theoretical writings. The compositional failings of the text present some advantages to the musical researcher. The work is divided into two speeches presented in a sympotic setting—the first delivered by a certain Lysias and the second by Soterichus—with introductory and concluding sections from the host Onesicrates. Each speech is primarily a vehicle to collect various expositions on musical subjects, with little original thought or comprehensive continuity. Because the different sources are fairly casually put together, the work contains many direct and extended citations from earlier authors.²⁰ However, the identification of these expositions is hindered by its somewhat

inconsistent naming of sources. Therefore we must be careful in seeking the influence of Aristoxenus, for there are times when it will appear as though we are in danger of circularity—that is, attributing a passage to Aristoxenus on the strength of its opinions, and then divining his opinions from it.

Despite the problems of identifying the sources precisely, we can trace the more important and obvious influences. The general source of Lysias' speech (1131f-1135d) is Heraclides, with some interpolations from other authors. Heraclides is cited at 1131f and apparently continues to be the source until the interruption of Glaucus of Rhegium and Alexander Polyhistor at 1132e-f. The probable (but unacknowledged) resumption of Heraclides as a source occurs at 1133a with the phrase ἄλλοι δέ τινες, but Glaucus is again cited at 1133f and 1134d.²¹ This speech includes also one specific citation of Aristoxenus, concerning Olympus and the invention of the enharmonic genus, which continues through the whole of the section 1134f to 1135b (Ch. 11). Aristoxenus' influence also seems to appear within the Heraclidean discussion of *nomoi*. At 1134a Lysias speaks of three purely Greek modes, Dorian, Phrygian and Lydian which contradicts Heraclides' statement elsewhere on the subject, while Aristoxenian sources tend to include these three as the traditional Greek modes.²²

It is the second part of the *De Musica*, the discourse of Soterichus, which depends on Aristoxenus most heavily and extensively. References to his writings include two citations from the *Peri Mousikes* (1136c and 1136f), a work examining musical tradition from an historical and social perspective. Also cited at length is a discussion on musical education and the moral utility of music (1142b-1145d) which closes Soterichus' speech and which can, owing chiefly to its continuity of thought and expression, be attributed to a single Aristoxenian work almost in its entirety.²³ Other passages from the Ps.-Plutarch are clearly the work of Aristoxenus, but are not expressly attributed to him by the author.

These citations from Aristoxenus in Ps.-Plutarch are supplemented by the work of Athenaeus. In the *Deipnosophistae* he refers to the authority of the author in over two dozen examples, and most of these have musical relevance. One citation (XIV 619d) also mentions the *Peri Mousikes* referred to in the Ps.-Plutarch. More significant, though, are the references to instruments, musicians, dance and the theatre which provide almost all the material for our knowledge on Aristoxenus' writings on those subjects.

Many of the fragments collected by Wehrli merely mention Aristoxenus in passing and refer to his musical status. Some authors refer to Aristoxenus as an archetypal authority on music, while in other fragments the epithet μουσικός is used in order to identify him. On the other hand, some fragments

demonstrate that, despite his much evidenced position as a musical authority, Aristoxenus was not entirely unchallenged. For example, in his defence of Plato, Proclus claims that the enharmonic was not the only genus treated by Aristoxenus' predecessors,²⁴ whilst Philodemus²⁵ and Plutarch²⁶ both contest Aristoxenus' claim that sight and hearing are superior to the other senses.

Specifically theoretical works are generally omitted from Wehrli's collection. He excludes not only the *Harmonics* and the *Rhythmics* from his discussion, but also references by Porphyry to other theoretical writings. Apart from the *On the Primary Chronos* discussed in the previous chapter, Porphyry briefly mentions a work *περὶ τόνων*.²⁷ There are also several references in the *Harmonics* itself to what seem to be previous works of Aristoxenus and which point to treatments of the *harmonikoi* and of acoustics. Finally, the work of many later music theorists shows the influence of Aristoxenus and there is much evidence concerning the reception and development of his harmonic theory. This latter material will be discussed in the following chapter.

2. WORKS AND THEMES

2a. History: The *Peri Mousikes*

Several fragments survive from a general work on music by Aristoxenus, the *Περὶ μουσικῆς*. It is referred to twice in the Ps.-Plutarchean *De Musica*²⁸ and once in Athenaeus' *Deipnosophistae*,²⁹ from which we can reasonably conjecture that it was a collection of musical data placed in an historical framework. The surviving fragments describe aspects of certain musical forms, focusing on their invention (by historical or pseudo-historical figures) or their traditional use in society. The three references provide somewhat limited information on their own but, taken in combination with other clearly Aristoxenian material in the Ps.-Plutarchean treatise, are sufficient to illuminate the probable contents and treatment of the subject.

Both references to the *Peri Mousikes* in the Ps.-Plutarch occur in a passage relating to the classification of modes which, apart from citing Aristoxenus, sets out the opinions of Plato (1136b and 1136e), Pindar (1136c), Dionysius Iambus (1136c) and the *harmonikoi* (1136d). Aristoxenus himself is cited three times in this discussion of modes and the first instance (referring to the first book of the *Peri Mousikes*) occurs early in Soterichus' speech. It concerns the putative historical use of the Lydian mode: "Ὀλυμπον γὰρ πρῶτον Ἀριστόξενοσ ἐν τῷ πρώτῳ περὶ μουσικῆς ἐπὶ τῷ Πύθωνί φησιν ἐπικήδειον αὐλῆσαι Λυδιστί.³⁰ It has been noted by the author of the passage that Plato rejected the Lydian mode in his discussion of the subject in the *Republic*,³¹ but here there is no indication of Aristoxenus'

opinion about the mode. He is cited merely to confirm its threnodic nature, after which Ps.-Plutarch offers different opinions of other authors on its origin.

Before discussing the second reference to the *Peri Mousikes* it should be noted that between the two citations specifically attributed to it, we find a comment which can reasonably be assumed to belong to that work also. It concerns similar material as the two citations surrounding it: Ἀριστόξενος δὲ φησιν Σαπφῶ πρώτην εὗρασθαι τὴν Μιξολυδιστί, παρ' ἧς τοὺς τραγωδοποιούς μαθεῖν λαβόντας γοῦν αὐτὴν συζεῦξαι τῇ Δωριστί, ἐπεὶ ἡ μὲν τὸ μεγαλοπρεπὲς καὶ ἀξιωματικὸν ἀποδίδωσιν, ἡ δὲ τὸ παθητικόν, μέμικται δὲ διὰ τούτων τραγωδία.³² Like the first quotation, this reference concerns the innovation of an historical figure—attributing to Sappho the invention of the Mixolydian mode—and indicates the mode's subsequent role in tragedy and the propriety of that role. It is again followed by an account offering an alternative to Aristoxenus' statement.

The second citation of the *Peri Mousikes* is, as in the first case, preceded by Plato's opinion but the meaning of the reference to Aristoxenus is ambiguous: τούτων δὲ τῶν ἀρμονιῶν τῆς μὲν θρηνηδικῆς τινος οὔσης, τῆς δ' ἐκλελυμένης, εἰκότως ὁ Πλάτων παραιτησάμενος αὐτὰς τὴν Δωριστί ὡς πολεμικοῖς ἀνδράσιν καὶ σώφροσιν ἀρμόζουσιν εἴλετο, οὐ μὰ Δία ἀγνοήσας, ὡς Ἀριστόξενός φησιν ἐν τῷ δευτέρῳ τῶν Μουσικῶν, ὅτι καὶ ἐν ἐκείναις τι χρήσιμον ἦν πρὸς πολιτείαν φυλακικὴν.³³ It is difficult to tell whether Aristoxenus is understood to be saying that Plato's limitation of modes was the result of ignorance or if he is cited to support Plato's authority on the subject. His well-known antipathy towards Plato³⁴ may suggest the former, and in this case the ignorance (ἄγνοια) may be associated with Aristotle's statement that the Socrates of the *Republic* restricted too much the modes which could be used by the state.³⁵ It is impossible that Aristoxenus thought that Plato was not aware of the existence of other modes (he has of course mentioned the Lydian in the *Republic* passage); the only question is whether Plato did not understand the appropriate uses for the modes.

The following argument in the Ps.-Plutarch does not throw much light on the matter. This passage is probably not from the same source as the statement about Plato since there is a marked disjunction between the accusation attributed to Aristoxenus and its refutation.³⁶ It equates ignorance about the existence of a mode or series of notes, with ignorance about possible uses of a mode. Yet the constant favourable references to older styles of playing suggest at least an author of similar disposition to Aristoxenus if not Aristoxenus himself.³⁷ Another problem of the passage is the glaring omission of any mention of the Phrygian mode which Plato included along with the Dorian.

This oversight undermines much of the authority of the passage since any author wanting to criticise Plato's use of modes would no doubt raise the issue of this selection, as Aristotle had done in the *Politics*.

The point in question relates to the appropriate use of music in society. Aristoxenus' conservative view on education shows a similar attitude to that maintained by Plato, from which it is clear that Aristoxenus is not opposed in principle to the limitation of musical styles in order to achieve a social or educational effect.³⁸ For example, later in the *De Musica* (1142e-f), Aristoxenus seems to approve of a number of communities who have done almost the same thing as Plato proposed to do in the relevant passage of the *Republic*.

The difficulty of assessing Aristoxenus' opinion on the employment of 'styles' (*tropoi*) or 'keys' (*tonoi*) is increased by the fact that the technical discussion on these subjects anticipated in the introduction of the *Harmonics* has not come down to us. However, it is not unlikely that Aristoxenus considered that musical education and activity should be controlled or at least influenced by the state, and so it seems reasonable to conclude that in the passage cited he confirms, rather than denies, Plato's knowledge on the subject. It remains a possibility that Aristoxenus is objecting to Plato's realisation of this limitation. In any case, the passage indicates that Aristoxenus' *Peri Mousikes* included discussion of the ethical aspects of the modes.

The final specific reference to the (fourth book of the) *Peri Mousikes* occurs in Athenaeus among a descriptive list of types of songs: 'Ἀριστόξενος δὲ ἐν τετάρτῳ περὶ Μουσικῆς "ἦδον, φησὶν, αἱ ἀρχαῖαι γυναῖκες Καλύκην τινὰ ὠδῆν. Στησιχόρου δ' ἦν ποίημα, ἐν ᾧ Καλύκη τις ὄνομα ἐρῶσα Εὐάθλου νεανίσκου σωφρόνως εὐχεται τῇ Ἀφροδίτῃ γαμηθῆναι αὐτῷ."³⁹ This citation demonstrates again how examples of the practical employment of music in society were described by Aristoxenus. The historical focus apparent in the references concerning Olympus and Sappho is also evident in this passage since the singers are described as αἱ ἀρχαῖαι γυναῖκες, and it is supported by the attribution of the composition to a specific poet of the sixth century, Stesichorus. The citation continues with a description of the song, noting that its story happened in Leucas (XIV 619e) and that the rejected and suicidal maiden is depicted as utterly chaste by the poet. The geographical specification suggests that the story was considered true and emphasises further the historical element of the Aristoxenian work.

Moreover, the passage following this in Athenaeus' text is also from Aristoxenus. Athenaeus states that in his κατὰ βραχὺ ὑπομνήματα, Aristoxenus comments on another song whose story and social context are presented in a similar fashion.⁴⁰ The parallels between the two citations should not be dismissed since they illustrate that Aristoxenus' historical and

social comments on the use of music cannot be presumed to be from the *Peri Mousikes* alone.

Taking into account the potential for error noted in the paragraph above, I believe that the direct evidence concerning the *Peri Mousikes* provides sufficient information to attribute one further passage to the work. Lysias' speech in the *De Musica* cites Aristoxenus as the authority for a statement about the innovations of the musician Olympus: "Ὀλυμπος δέ, ὡς Ἀριστόξενός φησιν, ὑπολαμβάνεται ὑπὸ τῶν μουσικῶν τοῦ ἑναρμονίου γένους εὐρετῆς γεγενῆσθαι· τὰ γὰρ πρὸ ἐκείνου πάντα διάτονα καὶ χρωματικά ἦν."⁴¹ The wording of this sentence admittedly actually only indicates Aristoxenus' reporting of the opinions of the *mousikoi*⁴² but, while it is difficult to know who these musical experts might be,⁴³ it still allows us to assume that he does not necessarily disagree with them. Furthermore, the continuity in tone and subject matter of this material up until 1135b, that is to the end of the penultimate paragraph of Chapter 11, indicates a single source.⁴⁴

Chapter 11 of the *De Musica* treats the invention of the enharmonic genus by Olympus and the connection of that genus to the spondeion scale. The parallel to other passages cited from the *Peri Mousikes* in subject matter and treatment is demonstrated in the attribution of a particular musical innovation to Olympus—who is also mentioned in the first reference to the *Peri Mousikes* (1136c)—and in the historically focused exposition. However, unlike the previous passages discussed, two of which refer to *harmoniai* exclusively, this passage focuses primarily on genus, although the source does state that Olympus is moving in the Dorian *tonos* (1135a). Even if this passage does not belong to the *Peri Mousikes*, the length and nature of the discussion present valuable evidence of Aristoxenus' ability to adopt various methodologies according to the contexts of his different works.

The different ways in which Aristoxenus treated similar subjects is highlighted by a comparison of this passage with some comments on genus in the *Harmonics*. In the passage cited in the *De Musica*, he not only attributes the invention of the enharmonic genus but sets out in detail the putative process by which this was achieved through the omission of the diatonic *lichanos*. His approach emphasises the practical rather than theoretical nature of the discovery through experimentation and the recognition of the beauty of the music created. In contrast, Aristoxenus' single diachronically oriented statement about the genera in the *Harmonics* is brief and, although it mentions the superior sophistication of the enharmonic genus, offers no account of its discovery: πρῶτον μὲν οὖν καὶ πρεσβύτατον αὐτῶν θετέον τὸ διάτονον, πρῶτον γὰρ αὐτοῦ ἢ τοῦ ἀνθρώπου φύσις προστυγχάνει, δεύτερον

δὲ τὸ χρωματικόν, τρίτον δὲ καὶ ἀνώτατον τὸ ἐναρμόνιον, τελευταίῳ γὰρ αὐτῷ καὶ μόλις μετὰ πολλοῦ πόνου συνεθίζεται ἡ αἴσθησις.⁴⁵ From this short historical note, the *Harmonics* proceeds into an exhaustive study on the precise technical construction and possible variation of each genus.⁴⁶

A further historical allusion occurs in the *Harmonics* concerning the enharmonic genus and ancient styles of performance: ὅτι δ' ἔστι τις μελοποιία διτόνου λιχανοῦ δεομένη καὶ οὐχ ἡ φαυλοτάτη γε ἀλλὰ σχεδὸν ἡ καλλίστη, τοῖς μὲν πολλοῖς τῶν νῦν ἀπτομένων μουσικῆς οὐ πάνυ εὐδηλὸν ἔστι, γένοιτο μεντὰν ἐπαχθεῖσιν αὐτοῖς· τοῖς δὲ συνειθισμένοις τῶν ἀρχαϊκῶν τρόπων τοῖς τε πρώτοις καὶ τοῖς δευτέροις ἱκανῶς δῆλόν ἔστι τὸ λεγόμενον.⁴⁷ It is significant that this digression, as well as the historical material referring to the chronological order of invention of the genera (19.22–29), only occurs in Book I of the harmonic treatise. In the revised version of Book II Aristoxenus has omitted even these brief extraneous comments. The reference to ancient styles of music belongs to an historical treatment of the subject, rather than one involving a technical description of the elements of contemporary music, and is excluded when Aristoxenus applies more strictly his definition of harmonic science as he does in Book II.

This kind of historical statement does, however, belong to the treatise cited in the *De Musica*, as shows a sentence with a striking resemblance to that cited above: ῥάδιον δ' ἔστι συνιδεῖν ἑάν τις ἀρχαϊκῶς τινος αὐλοῦντος ἀκούσῃ· ἀσύνθετον γὰρ βούλεται εἶναι καὶ τὸ ἐν ταῖς μέσαις ἡμιτόνιον.⁴⁸ The overlap of material referring to the enharmonic genus and the ancient style of playing offers confirmation of continuity between Aristoxenus and his source. Indeed, it indicates that Aristoxenus has contributed his own thoughts to those of the *mousikoi* or has even adopted the ideas of others into his later arguments, and does not merely report earlier opinions. As we have seen in the *Harmonics*, Aristoxenus often cites the work of his predecessors. In this case, however, there is a sense here that he is building on their material, rather than announcing its worthlessness.

Furthermore, although he reports his own disagreement with his sources, he does so without the extreme vehemence of the *Harmonics*. Mild disagreement occurs concerning the form of the συντονώτερος σπονδειασμός⁴⁹ and argues against the possibility of the spondeion being diatonic. The concurrence of material between the two works is once more brought into the foreground as Aristoxenus refers obliquely to a theorem included in the third book of the *Harmonics*. He uses the theorem that there cannot be two ditones in succession (1135b) in order to demonstrate that an

accepted version of the scale is contrary to the laws of music.⁵⁰ Unfortunately, the author does not state the actual form of the scale, since he has presumed the audience's familiarity with the structure, and it remains in doubt. However, the mention of the harmonic theorem indicates that the passage was probably written after the *Harmonics*—at least, after the first book—and if this is so, it is possible that Aristoxenus transferred the historical material mentioned above out of the first book of the *Harmonics* and into this work, leaving his technical treatise free from extraneous information.

Finally, the Ps.-Plutarchean passage throws light on Aristoxenus' conception of the enharmonic genus. Despite the claim of reporting the discovery of the enharmonic, the scale which Olympus achieves through the omission of the *lichanos* is actually only a possible precursor to the enharmonic. The resulting tetrachord of ditone and undivided semitone could belong to any genus depending on the placement of a fourth note in the tetrachord. The author is aware of this and specifically notes that the first enharmonic compositions did not have features specific to any of the genera (1135a). It seems then, that in defining the enharmonic genus the absence of the enharmonic *pyknon* is less important than the presence of the ditone interval. Indeed, Aristoxenus makes the point in the *Harmonics* that he despises the corruption of the enharmonic by contemporary performers who sharpen the *lichanos* in pursuit of sweeter sound and diminish the true ditone of the enharmonic (possibly to a major third, 5:4).⁵¹

The theoretical content of the passage in the *De Musica* is not central to the discussion, but we have seen that Aristoxenus assumes that the audience has some fairly technical knowledge of musical systems. While a precise description of the arrangement of intervals and notes is fundamental to the exposition concerning scales in the *Harmonics*, this material is omitted from the passage in the Ps.-Plutarch. Aristoxenus describes the structure of this precursor to the enharmonic scale only to demonstrate the process of invention. Thus, both accounts state that the enharmonic genus is younger and superior to the diatonic and chromatic, but the account of its invention by Olympus is an historical counterpart to the extensive technical and structural treatment of all three genera in the *Harmonics*. Although the passage in Ps.-Plutarch presupposes a detailed analysis of the structures of the genera, the material is quite differently treated. The exclusion of certain aspects of musicology from the second book of the *Harmonics* and their inclusion in other works is shown to be deliberate and demonstrates Aristoxenus' subject delineation.

Outside the Ps.-Plutarchean *De Musica*, there are some fragments which Wehrli believes may belong to the *Peri Mousikes* because they suggest an argument persuasive of the value of music.⁵² In these, Quintilian⁵³ mentions that

Aristoxenus and Archytas believe in the subordination of grammar to music; a passage from Philodemus⁵⁴ argues against Aristoxenus' belief in the superiority of sight and sound over the other senses (an idea earlier expressed in Aristotle *De Sensu* 436a and *Politics* 1340a28); and two commentators on Horace attribute to Aristoxenus remarks on the value placed by particular poets on books over companions.⁵⁵ While it is not unreasonable to speculate that these passages come from a source such as the *Peri Mousikes* it is notable that neither of them has the elements which we have seen to dominate all the references, that is historical explanations of tradition and innovation in music and the use of music in society. More likely candidates are a further fragment from Athenaeus⁵⁶ and one from the *Vita Sophoclis*⁵⁷ since they refer (respectively) to the discovery and later use of the Phrygian *harmonia*.

Despite some ambiguities of interpretation, it is possible to make some conclusions about the contents of the *Peri Mousikes*. It clearly discussed certain musical styles or *harmoniai*, and followed their invention by historical or pseudo-historical figures, and their development and use in society past and present. It had a scope for anecdote and maintained a more historical and sociological approach than the theoretical expositions of the *Harmonics* and the *Rhythmics*. Whereas the technical treatises show one aspect of the influence of Aristotelian scientific method, this material shows quite another. Taken together, these pieces of evidence intimate a Peripatetic method of scholarship, one which focuses on the gathering and cataloguing of a wide range of information within a certain subject, thus depending on previous research. The understanding in the *Harmonics* that Aristoxenus was working alone, on a science effectively untouched by other scholars, contrasts strongly to the cumulative approach of these historical and sociological musical writings. From this evidence we can see that Aristoxenus was a versatile author and thinker, capable of viewing the same material from multiple perspectives.

2b. Performance: Instruments, Dance, Performers

The predominance of the systematic collection and organisation of material over the development of a continuous theoretical argument is also apparent in the remains of Aristoxenus' works relating to aspects of performance. These cover a broad range of subjects including instruments, dance, and performers. Some of the citations containing this material are not attributed to any particular work and the general brevity of quotations from Aristoxenus limits the conclusions which can be drawn from them. The source is for the most part Athenaeus, supplemented by a few dictionary entries.

Two titles of works on instruments are cited by Athenaeus: the *Περὶ αὐλῶν καὶ ὀργάνων*,⁵⁸ and the *Περὶ αὐλῶν τρήσεως*,⁵⁹ while

Ammonius mentions the work *Περὶ ὀργάνων*.⁶⁰ As we noted above it is possible that the titles cited by Athenaeus may have been subsumed into the general work on instruments, or that the work on the boring of the aulos may have been part of that on auloi and instruments; it is difficult to say with certainty. On dance, only two works are attributed. There are three references, all dictionary entries or late compilations, to a work *Περὶ τραγικῆς ὀρχήσεως*⁶¹ whose fragments offer basic definitions of types of dance. Another work, the *Συγκρίσεις*, included material comparing different styles of dance used by different cultures as well as parallels between cultures.⁶² There are also citations not attributed to specific works: while one of these consists of a mere list of national dances,⁶³ others show a similarity to the more detailed material cited from the *Peri Mousikes*. Further passages relating to performance include the definition of roles of performers as well as writings on specific musicians. These include the titles *Περὶ αὐλητῶν*⁶⁴ and *Περὶ τραγωδοποιῶν*.⁶⁵

Many of the fragments concerning instruments and dance are concerned with catalogues and definitions. For example, in one instance Aristoxenus lists eight foreign stringed instruments⁶⁶ and in another five types of aulos.⁶⁷ The musician's opinion is also called upon by later writers to distinguish between instruments with similar names, as we see in Ammonius' reference to the precise definitions of the instruments *kitharis* and *kithara*.⁶⁸ In the works on dance, rather than merely cataloguing names, Aristoxenus again uses an historical perspective indicating the origins or social function of a traditional or regional dance. In this way, the description of the *πυρρίχη*⁶⁹ states the Spartan origin of the dance and its associations with war, and that of the *γυμνοπαϊδική*⁷⁰ describes some movements involved in the dance as well as its Dionysian connections. It is, therefore, possible that this kind of historical and sociological information was also included in the works on instruments. Definitions of other musical terms relating to performance also appear in the fragments. Athenaeus refers to Aristoxenus' definitions in the discussion of *hilarodia*, *magodia*, types of parody, and of the performers *magodist* and *lysiodist*.⁷¹

The work entitled *Συγκρίσεις* may not have been limited to the subject of dance. It follows the pattern of cataloguing information, as well as exemplifying how Aristoxenus made use of earlier literary forms. The rhetorical technique of comparison was one used by Isocrates⁷² among others and it may have been applied by Damon in his comparative study on the value of various *harmoniai* and rhythms.⁷³ Aristoxenus' adoption of this form indicates his willingness to employ methods of earlier scholars when it suits his purpose, but in this instance it is impossible to tell what the rest of the work included.

Likewise, the contents of other works evidenced by title or short citation are difficult to determine, and in some cases the subject of one fragment seems appropriate to a title cited elsewhere. It is possible, for example, that *περὶ αὐλητῶν*⁷⁴ was the source of Aristoxenus' report about where a certain performer learnt to play the aulos.⁷⁵ Yet in many cases little can be gleaned but the knowledge that Aristoxenus treats a certain subject. In two fragments Aristoxenus comments on the skill of parody achieved by particular performers.⁷⁶ In other fragments Aristoxenus mentions the genealogy of Socrates⁷⁷ and claims that Heraclides composed tragedy under the name of Thespis.⁷⁸ The work on tragic poets to which Ammonius refers⁷⁹ seems not to be merely biographical since the citation consists of the distinction between the words "rescue" (ρύεσθαι) and "protect" (ἐρύεσθαι) indicating that the kind of discussion indulged in by Aristoxenus perhaps referred to some of the themes of tragedy. These comments indicate a wide range of concerns in Aristoxenus' writings, but they are so brief and often so clearly out of context that little can be gained from them.

In a section of Athenaeus concerning the definition of the *magadis* and what kind of instrument it is, Aristoxenus is referred to four times. Twice Aristoxenus' association of the *magadis* and the *pektis* is reported,⁸⁰ thereby defining the *magadis* as a type of harp.⁸¹ This is supported by Aristoxenus' list of foreign stringed instruments which includes both the *pektis* and the *magadis*. Another reference suggests that the *magadis* is unlikely to be an *aulos* because Aristoxenus did not mention it in his writings *περὶ αὐλητῶν* or *περὶ αὐλῶν καὶ ὀργάνων*.⁸² In this last reference, Aristoxenus lists in his treatise *περὶ αὐλῶν τρήσεως* five types of aulos including the aulos *kitharisterion*.⁸³

A statement attributed to Aristoxenus concerns the relative value of wind and string instruments: ὁ μέντοι Ἀριστόξενος προκρίνει τὰ ἔντατὰ καὶ καθαπτὰ τῶν ὀργάνων τῶν ἐμπνευστῶν, ῥάδια εἶναι φάσκων τὰ ἐμπνευστά. πολλοὺς γὰρ μὴ διδαχθέντας αὐλεῖν τε καὶ συρίζειν, ὥσπερ τοὺς ποιμένας.⁸⁴ We gain from the comparison the fact that Aristoxenus is not merely concerned with listing definitions of instruments but that he offers a value judgement on them. This type of ethical consideration is typical of Aristoxenus' works on education, and it is possible that the citation comes from a sociologically-oriented work rather than a catalogue of instruments.

The possibility of corrupt or abridged citations must of course be acknowledged. In the list of stringed instruments attributed to Aristoxenus by one of the instruments mentioned in Athenaeus is the κλεψιάμβος,⁸⁵ whilst Hesychius cites Aristoxenus for the information that κλεψιάμβοι are certain songs by Alcman.⁸⁶

Aristoxenus also appears to be cited out of context by Philodemus who notes a distinction between musicians and musician-poets, and cites Aristoxenus in support in that he calls lyre-players (κρουματοποιοί) musicians.⁸⁷ Philodemus is attempting to undermine the theory of musical ethos by separating the ethical impact of poetry from the pleasure afforded by the music, but his argument does not reflect or mention Aristoxenus' clear adherence to an ethical doctrine.

Overall, the material on performance is consistent with a Peripatetic approach to scholarship and shows Aristoxenus cataloguing a variety of information. These collected pieces of evidence suggest that Aristoxenus wrote several works on different aspects of performance with a view to an encyclopaedic exposition of the material, and they are, in general, testament to his reputation in antiquity.

2c. Education: Ethos, Music in Society

The social aspects of music are much discussed by Aristoxenus and, as we have seen, two areas with which he was concerned were musical history and performance practice. In conjunction with these, there are several references to writings by Aristoxenus concerned with the moral effect of music on society and in particular with musical education, the doctrine of ethos, and the role of music in theatres and in the symposium. The principal witness for his opinions on these subjects is again Ps.-Plutarch's *De Musica*, and in particular the long section on musical education (Chs. 31–39). In this passage Aristoxenus often refers to the moral and ethical value of music, the importance of thorough training, and the appropriate use of music by the state and the individual.⁸⁸ In this respect, he shows a surprising affinity with theories in Plato's *Republic*.

This conservative attitude to musical activity is represented in the doctrine of ethos, which claims that music has an effect on the soul and on the character of the listener.⁸⁹ That this doctrine is of Pythagorean origin is evidenced in Iamblichus' *De Vita Pythagorae*, a work which sometimes uses Aristoxenus as a source, though not in contexts of this sort.⁹⁰ Aristoxenian fragments in other authors refer to ethos theory in relation to Pythagoras: in one Aristoxenus states that the Pythagoreans valued the cathartic benefits of music,⁹¹ while another associates Aristoxenus' opinion on the soul with that of Pythagoreans.⁹² The Pythagorean emphasis of Aristoxenus' thinking on education is most clearly demonstrated in a fragment from Strabo who cites the connection between musical education and moral discipline in Greece: ὅπου γε καὶ οἱ μουσικοὶ ψάλλειν καὶ λυρίζειν καὶ αὐλεῖν διδάσκοντες μεταποιοῦνται τῆς ἀρετῆς ταύτης. παιδευτικοὶ γὰρ εἶναι φασὶ καὶ ἐπανορθωτικοὶ τῶν ἡθῶν. ταῦτα δ' οὐ μόνον παρὰ τῶν

Πυθαγορείων ἀκούειν ἐστὶ λεγόντων, ἀλλὰ καὶ Ἀριστόξενος οὕτως ἀποφαίνεται.⁹³

The doctrine appears to have passed on to Plato through the under-documented figure of Damon of Oa. From the evidence of the *Republic* it seems that Damon analysed rhythms, metres and *harmoniai*, and promoted the association between music and behaviour. Plato demonstrates his acceptance of the theory of ethos in the *Republic* (398d ff.) as he outlines his reasons for rejecting the use of certain *harmoniai* in the Guardian-controlled state. The mixed and higher Lydian he rejects as threnodic (398e) and useless even to women, while some Ionian modes and the slack Lydian are rejected as soft and sympotic (μαλακαὶ τε καὶ συμποτικάί). The modes which he accepts—the Dorian and the Phrygian—are appropriate for the brave man in times of war and peace respectively (399a-b). Having rejected all but two modes, Plato further dictates that instruments of many strings or capable of playing many modes (πολύχορδα καὶ πολυαρμόνια) including the aulos, should be banned from the state. In the following passage of the *Republic*, Plato refers to the doctrine in relation to rhythm.

In the minds of such thinkers as Aristoxenus and Plato, the theory of ethos tends to promote a conservative attitude to music and it is clear that the ethical effect of music relates to many areas of musical activity. The two are agreed in their concern about the deterioration of contemporary music. In the *Republic* Plato refers to Damon's authority to justify the maintenance of musical customs: εἶδος γὰρ καινὸν μουσικῆς μεταβάλλειν εὐλαβητέον ὥς ἐν ὧν κινδυνεύοντα· οὐδαμοῦ γὰρ κινεῖνται μουσικῆς τρόποι ἄνευ πολιτικῶν νόμων τῶν μεγίστων, ὥς φησί τε Δάμων καὶ ἐγὼ πείθομαι.⁹⁴ In the *Laws* (700a ff.) Plato further describes the horrors of mixing musical styles and the resulting lawlessness created in musical tastes of the general public, particularly in theatre-goers. Aristoxenus also lamented the degeneration of music: Themistius recalls Aristoxenus' exhortation to his students to avoid the "womanly" (θηλυνομένη) music of the theatres in favour of more manly, but less popular, songs.⁹⁵ Athenaeus cites comments from Aristoxenus' Σύμμικτα συμποτικά which compare the corruption of musical practices to the barbarisation of the Greeks of Poseidonia: οὕτω δὲ οὖν, φησί, καὶ ἡμεῖς, ἐπειδὴ καὶ τὰ θεάτρα ἐκβεβαρβάρωται καὶ εἰς μεγάλην διαφθορὰν προελήλυθεν ἡ πάνδημος αὕτη μουσική, καθ' αὐτοὺς γεγόμενοι ὀλίγοι ἀναμινησκόμεθα οἷα ἦν ἡ μουσική.⁹⁶

The degeneration of modern music is also the theme of another passage in the *De Musica* (1140a-1142b), which—although unattributed—contains subjects reflecting the concerns of Aristoxenus and Plato. They include the superiority of sight and sound to the other senses (Ch. 25), maintenance of

musical customs by the ancients (Ch. 26), and the decadence of modern practice (Ch. 27). This is followed by a history of the progress (or corruption) of music up until Philoxenus, including a citation of the comic poet Pherecrates.⁹⁷ The opinions presented certainly conform to Aristoxenus' conservative stance on the subject, and the inclusion of discussion concerning the authors of musical innovation with Olympus⁹⁸ as the inventor of the enharmonic genus (1141b) suggest that Aristoxenus is the author.⁹⁹ Unfortunately, this cannot really be verified and the possibility is further undermined in particular for Chapter 25 as its beginning distinctly recalls Pythagorean cosmological harmonics.¹⁰⁰

Although he admits the influence of music on character, Aristotle is considerably less dogmatic than Plato on the use of modes. In the *Politics* he describes the effects of the *harmoniai*: the Mixolydian inspires grief, the slack modes inspire relaxation, the Dorian moderation, and the Phrygian excitement. From this Aristotle concludes that music must be used in education: ἐκ μὲν οὖν τούτων φανερόν ὅτι δύναται ποιοῦν τι τὸ τῆς ψυχῆς ἡθὸς ἢ μουσικὴ παρασκευάζειν, εἰ δὲ τοῦτο δύναται ποιεῖν, δῆλον ὅτι προσακτέον καὶ παιδευτέον ἐν αὐτῇ τοὺς νέους.¹⁰¹ Aristotle does not reject any of the modes outright, but later in the discussion (1342a1 ff.) he states that they each have a different role to play in society. The moral modes are important for education, the inspiring ones can have a cathartic effect, and different modes are appropriate for the entertainment of the educated listener and the masses.

The doctrine of ethos appears in a variety of forms throughout antiquity, perhaps reflecting changes in musical practice. While Plato and Aristotle emphasise the effect of rhythms and *harmoniai*, other theorists highlight different elements of music, such as the genera. Cleonides and Aristides Quintilianus both state that there are three *ethe* of melody, the *diastaltic* (elevated), *systaltic* (depressed), and *hesychastic* (intermediate and calming).¹⁰² Aristides also remarks that notes differ in ethos according to where they are positioned in the tetrachord: ἕτερα γὰρ ἦθη τοῖς ὀξυτέροις, ἕτερα τοῖς βαρυτέροις ἐπιτρέχει, καὶ ἕτερα μὲν παρυπατοειδέσιν, ἕτερα δὲ λιχανοειδέσιν.¹⁰³ In a further explanation he describes notes as male, female or intermediate, and says that the ethos of a melody is influenced by which type of note is predominant in it, with the suggestion that the lower notes are male, the higher female.¹⁰⁴

Aristoxenus may have favoured an ethos based on genera, although he nowhere rejects a modal basis.¹⁰⁵ In addition, while the *Harmonics* does not directly promote the doctrine of ethos, Aristoxenus' thorough examination of all the genera, and the particular praise of the enharmonic genus, may

support a framework on which his ethical doctrine can rest. However, this proposition cannot be confirmed anywhere in Aristoxenus' surviving work. Equally he may have considered the ethical effect of music to lie in the combination of genera and *harmonia*, as Clement seems to attest: προσήκει δὲ εὖ μάλα τὸ ἐναρμόνιον γένος τῇ δωριστὶ ἁρμονίᾳ καὶ τῇ φρυγιστὶ τὸ διάτονον, ὥς φησιν Ἀριστόξενος.¹⁰⁶ Aristoxenus' emphasis on the proper combination of elements in music may be an extension of this theory.

A doctrine of ethos based on genera is, interestingly, the primary object of attack in an anonymous text written probably shortly before the time of Aristoxenus.¹⁰⁷ The author of the *Hibeh Papyrus* 13 argues against ethical associations of music and ridicules the theories of "harmonicists": τίς γὰρ οὐκ οἶδεν [Αἰτ]ωλοὺς καὶ Δόλοπας καὶ πάντας τοὺς θυ[οντας] Θερμοπύλ]ησι διατόνῳ μὲν τῇ μουσικῇ χρω[μένους, πολὺ] δὲ τῶν τραγωιδῶν ὄντας ἀνδρειο[τέρους] τῶν διὰ πα[ντὸς] εἰωθότων ἐφ' ἁρμονίας αἰδεῖν; [ὥστε δῆλον ὅτι οὐτε] χρωμα δειλοὺς οὐτε ἁρμονία ἂν [ἀνδρείους] ποιήσῃεν.¹⁰⁸ The rejection of ethos theory may also be implicit in Epicurus' argument against Aristotle's concept that sight and sound have more value than the other senses.¹⁰⁹ Similarly, when Philodemus explicitly disputes the same doctrine in his own *De Musica*, Aristoxenus is one of the objects of his attack.¹¹⁰ It is clear that a belief in the doctrine of musical ethos was by no means universal in antiquity.

The citation on musical education contained in the Ps.-Plutarchean treatise is the primary evidence for the doctrine of ethos according to Aristoxenus. The extract contains a mixed collection of information, loosely relating to three principal subjects. The primary theme is training in music, and the importance of appropriate styles. The second relates to the science of harmonics, and exemplifies the limits of harmonic education in relation to the desired extent of a musician's knowledge. Finally, historical and cultural examples are employed to illustrate the value of certain musical practices. Throughout the text, Aristoxenus advances an holistic approach to music science, which is made up of supplementary branches such as harmonics or rhythemics, all of which must be mastered if music is to be appreciated fully. This argument is similar to that of Plato's *Phaedrus* 268a-274b, which demonstrates the insufficiency of knowing the parts of a science but not its wider application; thus it appears that knowing the elements of music is not enough to compose music in an appropriate way. Further echoes of Plato are apparent in the general disdain for modern music and the emphasis on proper education.

The first theme—of correct training—is exemplified in the opening remarks of the section: ὅτι δὲ παρὰ τὰς ἀγωγὰς καὶ τὰς μαθήσεις διόρθωσις ἢ διαστροφὴ γίνεται δῆλον Ἀριστόξενος ἐποίησεν.¹¹¹ The

comment sets the tone for the remainder of Soterichus' speech and is supported by the subsequently related story, in which it is said that Telesias of Thebes found himself unable to compose 'corrupt' melodies in the style of Philoxenus and Timotheus because of careful musical training in his youth.

The historical theme is also quickly established in the text. After complaining that there has been no systematic enumeration of the educational use of modes, Aristoxenus cites the discerning behaviour of Spartans, Mantineans and Pelleneans who restricted the number of modes which could be taught: ἓνα γάρ τινα τρόπον ἢ παντελῶς ὀλίγους ἐκλεξάμενοι οὕς ᾤοντο πρὸς τὴν τῶν ἡθῶν ἐπανόρθωσιν ἀρμόττειν, ταύτῃ τῇ μουσικῇ ἐχρῶντο.¹¹² A further historical example is presented with the description of Olympus' enharmonic genus in the Phrygian mode and *paion epibatos* rhythm which creates the ethos of the opening of the nome of Athena (1143b). The author adds that this ethos can be altered by maintaining the genus and *harmonia* but changing the rhythm to trochees as occurs in the body of the nome.

It is reiterated at this point by Aristoxenus that the knowledge of harmonics and rhythmic does not concern the issue of propriety, and that this is a matter for critical judgement: ἀναγκαῖον οὖν δύο τοῦλάχιστον γνώσεις ὑπάρχειν τῷ μέλλοντι διαγνώσεσθαι τό τε οἰκῆιον καὶ τὸ ἀλλότριον· πρῶτον μὲν τοῦ ἡθους οὗ ἔνεκα ἡ σύνθεσις γεγένηται, ἔπειτα τούτων ἐξ ὧν ἡ σύνθεσις.¹¹³ Again there is evidence of the influence of Plato who, in a passage concerning music criticism in the *Laws* 669b ff., states that only with thorough training in the elements of music is it possible to avoid inappropriate performance or composition. Propriety is not only associated with putting the correct tune and gestures together but also ensuring that the result is suitable for the performer: οὐ γὰρ ἂν ἐκεῖναί γε ἐξαμάρτοιεῖν ποτε τοσοῦτον, ὥστε ῥήματα ἀνδρῶν ποιήσασαι τὸ σχῆμα γυναικῶν καὶ μέλος ἀποδοῦναι, καὶ μέλος ἐλευθέρων αὖ καὶ σχήματα ξυνθεῖσαι ῥυθμούς δούλων καὶ ἀνελευθέρων προσαρμόττειν.¹¹⁴

The initial example of harmonic analysis occurs with the enumeration of the divisions of music into diatonic, chromatic and enharmonic genera (1142d). Then, after the historical example cited above concerning the limitation of modes by Spartans, Mantineans and Pelleneans, Aristoxenus proposes to enumerate the disciplines of music and to what each relates (1142f). The field of harmonics, he states, includes pitch, intervals, tetrachords, notes, modes, and modulation between tetrachords. Specifically it does not include propriety of composition and to illustrate this point Aristoxenus turns again to history. He discusses the composer of the *Mysians*, Philoxenus—mentioned

above in relation to Telesias—to exemplify the issue of propriety, in particular which modes should be used for which styles of composition.¹¹⁵ Aristoxenus separates this skill from the domain of harmonic science, dividing knowledge about scale structures (which are stable) from ability in melodic composition (which incorporates their variable application): φανερόν δὲ ὅτι ἑτέρα τοῦ συστήματος ἡ φωνὴ τῆς ἐν τῷ συστήματι κατασκευασθείσης μελοποιίας, περὶ ἧς οὐκ ἔστι θεωρῆσαι τῆς ἀρμονικῆς πραγματείας.¹¹⁶ The same argument is then said to apply to rhythm also.

As Aristoxenus' discussion in his educational work moves onto the subject of genera, it raises the complaint familiar to us from the *Harmonics* (2.8–25) that “our predecessors” (οἱ πρὸ ἡμῶν) only studied the enharmonic genus and only within the octave range (1143e). The temporal reference can only relate to Aristoxenus, and it demonstrates the carelessness with which the author of the *De Musica* has transposed large portions of text into his treatise. Further themes from the *Harmonics* appear in the assertion that both reason and perception are essential to understanding the elements of musical composition. The idea of continuity, which is emphasised in the *Harmonics*, also appears in this educational work. The treatise states that the three elements of music are immediately perceptible but require continuity (συνέχεια) in order that critical judgement can be applied. The note, the beat and the syllable must all be part of a continuing process in order that the structure of the scale, the rhythm, and the poetry can be appreciated fully (1144a-b).

The discussion turns back again to ethos and to the idea that even possessing knowledge of all the various branches of music does not guarantee that one is a fully competent musician. The emphasis on critical judgement expresses the prime purpose of education in music, that is, an appreciation of its ethical effect. Again Aristoxenus resorts to an historical example, saying that the ancients preferred the majesty and directness (σεμνὸν καὶ ἀπερίεργον, 1144f) of ancient styles of music.

An interesting paragraph concerning Pythagoras falls at this point. As it is quite short, it is worth quoting in full: Πυθαγόρας δ' ὁ σεμνὸς ἀπεδοκίμαζεν τὴν κρίσιν τῆς μουσικῆς τὴν διὰ τῆς αἰσθήσεως· νῶ γὰρ ληπτὴν τὴν ταύτης ἀρετὴν ἔφασκεν εἶναι. τοιγάρτοι τῇ μὲν ἀκοῇ οὐκ ἔκρινεν αὐτήν, τῇ δὲ ἀναλογικῇ ἀρμονίᾳ· αὐταρκές τ' ἐνόμιζεν μέχρι τοῦ διὰ πασῶν στήσαι τὴν τῆς μουσικῆς ἐπίγνωσιν.¹¹⁷ At first reading it seems as though this is not from Aristoxenus, on account of his much attested rejection of the Pythagorean method of interval evaluation through number ratios, and his criticism of analyses limited to the octave interval. Yet the possibility of Aristoxenus' authorship must still be

considered, for it should be recalled that his admiration of Pythagoras and of the Pythagoreans is firmly attested in his extensive writings on the subject¹¹⁸ and while he rejects the ratio-calculation methodology as an approach to harmonics, he never criticises the teachings of the school itself. The present passage merely reports Pythagoras' opinion without comment, and its author does not actually claim to subscribe to the view in relation to harmonic study. Although even indirect approval of this method appears incongruous for Aristoxenus, it perhaps indicates that the dichotomy between the two schools of harmonics was exaggerated by later theorists.

If the paragraph on Pythagoras is an interpolation—and it does seem to interrupt the argument—the following passage in the Ps.-Plutarch, concerning the corruption of the enharmonic genus, continues its quotation of Aristoxenus. It contains two further anachronisms: the speaker refers to “our contemporaries” (οἱ δὲ νῦν, 1145a) and also complains that the enharmonic genus has been abandoned. (This event occurred around the time of Aristoxenus, not of the speaker Soterichus.¹¹⁹) Aristoxenus objects to that fact that the enharmonic *diesis* (quarter-tone) has been rejected by people because it is difficult to perceive and unable to be found by means of concords.¹²⁰ The deterioration of the enharmonic genus is familiar from the *Harmonics* as Aristoxenus refers to its difficulty (19.27–29) and comments on its corruption (23.1–23, admittedly in reference to the ditone, not to the *diesis*).

The rejection of the enharmonic genus on the grounds that its intervals cannot be found by means of concords is also criticised by Aristoxenus, since this would imply that any interval which is an odd-multiple of a *diesis* would also be rejected. This terminology does not appear anywhere else in Aristoxenus' writings but it is used in the work of Aristides Quintilianus who states that the odd/even opposition is one of the distinguishing features of an interval.¹²¹ Aristoxenus complains about the hypocrisy of those musicians who in practice use intervals which are odd-multiples of a *diesis* or irrational (ἄλογος) intervals (1145d), while rejecting them in theory. Aristoxenus' criticism can only be understood as very general, or it has been misrepresented since he refers to the flattening of fixed notes, a practice which is otherwise unknown. In the present passage the use of the term “irrational” to describe an interval seems to imply a Pythagorean account, but Aristoxenus merely uses the term “rational” to indicate an interval which belongs in melody, or else one which is commensurate with such an interval. The concept is presented similarly in the *Rhythmics*: τὸ δὲ κατὰ τοὺς τῶν ἀριθμῶν λόγους λαμβανόμενον ῥητὸν τοιοῦτόν τι δεῖ νοεῖν οἷον ἐν τοῖς διαστηματικοῖς τὸ δωδεκατημόριον τοῦ τόνου καὶ εἴ τι τοιοῦτον ἄλλο ἐν ταῖς τῶν διαστημάτων παραλλαγαῖς λαμβάνεται.¹²²

The close of the speech of Soterichus and the Aristoxenian treatise on education turns again to general comments on the value of music, illustrating the point with an Homeric scene depicting Achilles, who was trained in music by Cheiron, calming himself with music (II 9). The subject of correct musical training thereby emerges a final time before Aristoxenus sums up his thesis: εἰ γοῦν τις τὸν παιδευτικὸν τῆς μουσικῆς τρόπον ἐκπονήσας τύχοι ἐπιμελείας τῆς προσηκούσης ἐν τῇ τοῦ παιδὸς ἡλικίᾳ, τὸ μὲν καλὸν ἐπαινέσει τε καὶ ἀποδέχεται, ψέξει δὲ τὸ ἐναντίον ἐν τε τοῖς ἄλλοις καὶ ἐν τοῖς κατὰ μουσικὴν, καὶ ἔσται ὁ τοιοῦτος καθαρὸς πάσης ἀγεννοῦς πράξεως.¹²³

The Aristoxenian work on education on which the Ps.-Plutarch depends cannot be securely dated in relation to the *Harmonics*, but it may have been written before either version of that treatise. Many of the themes of the *Harmonics* seem to have appeared in this work, including the insufficiency of earlier treatments of scale systems, the degeneration of the enharmonic genus, the need to divide music into different areas for investigation, and the two-fold method of understanding music which compares the stable structures of the scale systems and their variable use in composition. However, the expositions are less developed and organised and this is unlikely to be the effect of the epitomiser, as Ps.-Plutarch, so far as we can tell, represents the substance of his sources faithfully enough, and sometimes quotes them verbatim. Themes which appear in the educational treatise but not in the *Harmonics* focus on the propriety of musical composition and the educational benefits of music. This is often expressed through historical examples and shows many similarities with Plato's remarks on musical education, including a marked tendency towards conservatism.

The conclusion of the sympotic *De Musica* contains remarks delivered by the host Onesicrates concerning Aristoxenus' opinions on music in the symposium. He reiterates the many levels on which music has a moral influence, including the calming effect it has on symposium participants: συνέβαινε γὰρ εἰσάγεσθαι μουσικὴν ὥς ἱκανὴν ἀντισπᾶν καὶ πράυνειν τὴν τοῦ οἴνου ὑπόθερμον δύναμιν, καθάπερ πού φησιν καὶ ὁ ὑμέτερος Ἀριστόξενος· ἐκεῖνος γὰρ ἔλεγεν εἰσάγεσθαι μουσικὴν παρόσον ὁ μὲν οἶνος σφάλλειν πέφυκεν τῶν ἄδην αὐτῷ χρησαμένων τά τε σώματα καὶ τὰς διανοίας, ἡ δὲ μουσικὴ τῇ περὶ αὐτὴν τάξει τε καὶ συμμετρίᾳ εἰς τὴν ἐναντίαν κατὰστασιν ἄγει τε καὶ πράυνει.¹²⁴ Further evidence of Aristoxenus' work on a sympotic theme is cited by Athenaeus. Aristoxenus was not averse to adopting an earlier literary form as a vehicle for his musical theories. Theophrastus gives an alternative example of the healing value of music, when he reports that Aristoxenus had

cured a man of madness caused by the sound of the salpinx through the gradual exposure to the aulos.¹²⁵

In Aristoxenus' works on history and performance, subjects mentioned briefly in the harmonic treatise are given fuller treatment elsewhere, and this is seen again in relation to ethos theory. The *Harmonics* offers inconclusive evidence on Aristoxenus' commitment to this important philosophical doctrine. A reference in the first book of the *Harmonics* appears to relate the *tessitura* of a *systema* to the effect of a melody composed in it. Aristoxenus complains that the harmonicists compress their diagrams of the *systemata* and obscure the relationships between them: ἐπεὶ δὲ τῶν συστημάτων ἕκαστον ἐν τόπῳ τινὶ τῆς φωνῆς τεθὲν μελωδεῖται καί, καθ' αὐτὸ διαφορὰν οὐδεμίαν λαμβάνοντος αὐτοῦ, τὸ γιγνόμενον ἐν αὐτῷ μέλος οὐ τὴν τυχοῦσαν λαμβάνει διαφορὰν ἀλλὰ σχεδὸν τὴν μεγίστην.¹²⁶ While this seems a fairly tenuous connection to the theory of ethos, it is worth mentioning in the light of the emphasis which Aristoxenus places on the association of *systemata* (particularly the *tonoi*) and regions of the voice, and the implications this has for the nature of *systemata*. Aristides Quintilianus' association of lower notes with a male ethos and higher notes with a female ethos is conceivably an extension of these ideas.

The second book of the *Harmonics* offers a more general statement about the validity of ethos theory, but again no real confirmation. Aristoxenus cautions the audience against assuming that a lecture on harmonic science will be of moral benefit to them, as had a previous audience: παρακούσαντες τῶν ἐν ταῖς δείξεσι λόγων ὅτι πειρώμεθα ποιεῖν τῶν μελοποιῶν ἕκαστην καὶ τὸ ὅλον τῆς μουσικῆς, ὅτι ἡ μὲν τοιαύτη βλάπτει τὰ ἡθῆ ἡ δὲ τοιαύτη ὠφελεῖ, τοῦτο αὐτὸ παρακούσαντες, τὸ δ' ὅτι καθ' ὅσον μουσικὴ δύναται ὠφελεῖν οὐδ' ἀκούσαντες ὅλως.¹²⁷ Taken without the other evidence of the fragments, this might suggest that Aristoxenus has little commitment to the idea of ethos. Since other sources do indicate that Aristoxenus supported the doctrine, perhaps his qualification is meant to suggest that the appropriate music alone cannot rescue a degenerate soul or that music would be only part of a proper educational system. These two examples are insufficient on their own to establish Aristoxenus' opinion on ethos but the evidence from the *De Musica* demonstrates a firm commitment.

It is clear from a range of sources, and in particular from his treatise on musical education, that Aristoxenus frequently commented upon the ethical potential of music. His hostility to innovation in musical practice (contrasting starkly to his innovative stance in music theory) can be connected to his belief in the ethical influence of musical styles and the role which music therefore

must play in education. In this way he reflects the opinions of Plato on musical practice and was certainly influenced by Pythagorean philosophy on the matter. The precise nature, indeed the existence, of a complete and unified Aristoxenian theory of ethos cannot be determined from the evidence available to us. Nonetheless, his support for the general notion places him firmly alongside his intellectual forbears.

2d. Theory: *Harmonikoi*, Acoustics

Besides the *Harmonics* and the *Rhythmics*, Aristoxenus appears to have written other works on technical musical subjects. The principal sources for these works are Porphyry's *Commentary on Ptolemy's Harmonics* and Aristoxenus' own *Harmonics*. In the first book of the *Harmonics* there are four clear references to a work on the theories of the *harmonikoi* as well as a possible reference to an acoustic work. The latter reference is supported by a citation in the scholia to Plato's *Phaedo*. While these examples are primarily inferred from Aristoxenus' own writings, specific titles are preserved by Porphyry. Porphyry, who quotes extensively from the *Harmonics*, cites a rhythmic work *Περὶ τοῦ πρώτου χρόνου*¹²⁸ and three works concerned with melody: the *Περὶ τόνων*¹²⁹ the *Περὶ μελοποιίας*¹³⁰ and the *Σύμμικτα ὑπομνήματα*.¹³¹ It is significant that the material contained in all these fragments can also be found in either the harmonic or the rhythmic treatise.

Book I of the *Harmonics* provides ample evidence that Aristoxenus wrote a critical work on the *harmonikoi*, the vaguely defined group of musical theorists operating before and during Aristoxenus' career.¹³² The first mention of it occurs early in the work, criticising the lack of depth in their examination of musical structures: ὅτι δ' οὐδένα πεπραγμάτευνται τρόπον οὐδὲ περὶ αὐτῶν τούτων, ὧν ἡμένοι τυγχάνουσι, σχεδὸν μὲν ἡμῖν γεγένηται φανερόν ἐν τοῖς ἔμπροσθεν ὅτε ἐπεσκοποῦμεν τὰς τῶν ἀρμονικῶν δόξας.¹³³ In fact, this criticism provides the structure for the exposition of the first book of the *Harmonics* which describes the parts of the science. The other three references to the work on *harmonikoi* are all contained in this expositional section, and each part of the science is described in relation to the inadequate method with which harmonicists treated it. Particular attention is drawn to the fact that the earlier theorists only treated the enharmonic genus and that they restricted their analysis to within the octave.¹³⁴ Indeed it seems that Aristoxenus' division of the subject into parts was prompted by the need to highlight and then to repair the errors and omissions made by these earlier theorists. On intervals, for example, Aristoxenus notes: περὶ ἧς οἱ πλείστοι τῶν ἀρμονικῶν οὐδ' ὅτι πραγματευτέον ἦσθοντο· δῆλον δ' ἡμῖν ἐν τοῖς ἔμπροσθεν γέγονεν.¹³⁵

While most of his comments on the harmonicists are negative, Aristoxenus acknowledges that Eratocles and his school have at least attempted to say something about one part of harmonics, the *systemata*. He spends some time in describing the achievements of Eratocles in this area (5.10–6.33) although every point is qualified with a remark on the incomplete nature of that research. It is possible that much of this section was taken from Aristoxenus' own earlier work, as he summarises his opinion and reminds the audience of previous expositions on the subject: Ἐρατοκλῆς δ' ἐπεχείρησεν ἀναποδείκτως ἐξαριθμεῖν ἐπὶ τι μέρος· ὅτι δ' οὐδὲν εἴρηκεν ἀλλὰ πάντα ψευδῇ καὶ τῶν φαινομένων τῇ αἰσθήσει διημάρτηκε, τεθεώρηται μὲν ἔμπροσθεν ὅτ' αὐτὴν καθ' αὐτὴν ἐξητάζομεν τὴν πραγματείαν ταύτην.¹³⁶ The section on Eratocles ends with one last reference to earlier explanations (6.32–33) and then turns back to Aristoxenus' own organisation of harmonic science.

In general, this earlier work seems to have treated the achievements of different theorists as well as providing an opportunity for Aristoxenus to enumerate in detail their failings. It is significant that the remarks referring to it all occur in the first book of the *Harmonics*, as though the criticism set out in the earlier work provides the structure for his initial exposition. Certainly, these references are absent from the second book of the *Harmonics*.¹³⁷ When Aristoxenus revises this section it is considerably better organised, with a list of seven parts neatly enumerated. There is still criticism of the methodologies of other scholars, but the second exposition works around a positive framework, describing the issues relating to each part, rather than on the negative framework of the first book, which highlighted what was missing from earlier treatments of each part.

There is also evidence for a work on the other principal musical-theoretical approach which Aristoxenus rejected for harmonic science, that based on mathematics. In the passage on the movement of the voice in Book I of the *Harmonics*, Aristoxenus refers specifically to some of the theories of acoustics promoted by the Pythagoreans (who, unlike Eratocles, remain unnamed). Throughout this discussion (8.13–12.32), Aristoxenus emphasises his preference for the evidence of perception over that based on acoustic theory. For instance, near the end of the discussion he mentions several theories which are irrelevant to his understanding of musical sound: μὴ ταραττέτωσαν δ' ἡμᾶς αἱ τῶν εἰς κινήσεις ἀγόντων τοὺς φθόγγους δοῖναι καὶ καθόλου τὴν φωνὴν κίνησιν εἶναι φασκόντων, ὥς συμπεσουμένου λέγειν ἡμῖν ὅτι συμβήσεται ποτε τῇ κινήσει μὴ κινεῖσθαι ἀλλ' ἡρεμεῖν τε καὶ ἐστάναι . . . οὐδὲν γὰρ ἦττον ἡμεῖς τότε φήσομεν ἐστάναι τὴν φωνήν, ὅταν ἡμῖν ἡ αἰσθησις αὐτὴν ἀποφῇνη

μήτ' ἐπὶ τὸ ὀξύ μήτ' ἐπὶ τὸ βαρὺ ὁρμῶσαν, οὐδὲν ἄλλο ποιοῦντες πλὴν τῷ τοιούτῳ πάθει τῆς φωνῆς τοῦτο τὸ ὄνομα τιθέμενοι . . . εἰ δὲ κινεῖται μὲν τὴν ὑφ' ἡμῶν λεγομένην κίνησιν, ἐκείνης τῆς κινήσεως τῆς ὑπ' ἐκείνων λεγομένης τὴν κατὰ τάχος διαφορὰν λαμβανούσης, ἡρεμεῖ δὲ πάλιν αὖ τὴν ὑφ' ἡμῶν λεγομένην ἡρεμίαν, στάντος τοῦ τάχους καὶ λαβόντος μίαν τινὰ καὶ τὴν αὐτὴν ἀγωγὴν, οὐδὲν ἂν ἡμῖν διαφέρει.¹³⁸ The theories mentioned here recall Archytas' assertion (also surviving in Porphyry) about the relative speeds of high and low sounds.¹³⁹ Aristoxenus does not deny the validity of these ideas, he merely claims that perception is the essential criterion for his own study. The association of these ideas with those of Archytas and the fact that Aristoxenus wrote a favourable biography of the Pythagorean suggest that Aristoxenus may uphold the acoustic theories of his predecessor even if he does not apply them to harmonic science.

The details involved in this discussion, like the detail of the faults of the *harmonikoi*, suggests a summary of an earlier work. This is perhaps a further reason why the entire discussion on the movement of the voice is omitted from the revision which appears in Book II. Even in the passage from Book I, Aristoxenus finds it necessary to limit his discussion: ταῦτα μὲν οὖν ἐνταῦθα ἱκανῶς, ἐν ἄλλοις δὲ ἐπιπλεῖόν τε καὶ σαφέστερον διώρισται.¹⁴⁰ While this on its own does not necessarily indicate that the fuller explanation was composed by Aristoxenus, it is supported by the other evidence in the *Harmonics* that he wrote a work on acoustics. This is a subject in which he is clearly conversant, as we would expect from his earlier Pythagorean education.

Another piece of evidence for an acoustic work occurs in the scholia to Plato's *Phaedo*¹⁴¹ commenting on the "skill of Glaucon" (Γλαύκου τέχνη). Glaucon is said by Aristoxenus in the *Περὶ τῆς μουσικῆς ἀκροάσεως* to have attempted to make music using notes created by four discs of equal diameter made by Hippasus of Metapontum. Because of their different thickness, the set of discs sound different pitches which make up the basic intervals of fourth, fifth and octave. The proportions of the thicknesses are described by Aristoxenus in completely numerical terms. He does not mention the names of the intervals familiar from the *Harmonics* but uses the terminology of Pythagorean musicology and names the ratios themselves—epitritic, hemiolic, and double.

Apart from these instances of works specifically in response to earlier harmonic theories, there is evidence that Aristoxenus devoted individual discussions to subjects which appear in the harmonic and rhythmic treatises. Porphyry mentions four titles of theoretical works which suggest either preliminary essays on subjects which were later combined into a co-ordinated

music theory, or supplementary explanations of material not understood in its first exposition. The possibility that Porphyry is giving vaguely descriptive titles to his own paraphrasing of sections of the *Harmonics* can be dismissed. Despite the similarities between these passages and sections from the *Harmonics* it is unlikely that Porphyry is confusing his sources since he cites accurately and often from the harmonic treatise.

The rhythmic fragment from *On the Primary Chronos* which treats the possibility of infinite variety in the length of a beat was discussed in our last chapter. Just before this citation Porphyry briefly cites from Aristoxenus' *Περὶ τονῶν*,¹⁴² which refers to the potentially infinite variety of pitch. The subject of an infinite variety of pitch is also treated in all three books of the *Harmonics* (26.14–28, 47.9–49.8 and 68.14–20). The juxtaposition of these two fragments by Porphyry highlights the continuity between the concepts of Aristoxenus' rhythmic and harmonic treatises.

The two other fragments preserved by Porphyry also treat subjects included in the harmonic treatise. A fragment attributed to the fourth book of the *Περὶ μελοποιίας*¹⁴³ defines the possible melodic divisions of the tone, a discussion repeated in Books I and II of the *Harmonics* (21.20–31 and 46.3–8). While both the discussions in the *Harmonics* state that the smallest melodious intervals are the quarter, third and half tone, the discussion from the *Περὶ μελοποιίας* expresses these intervals in terms of fractions of twelve, that is 3, 4 and 6, indicating a more mathematical than empirical conception. The final fragment from the *Σύμμικτα ὑπομνήματα*¹⁴⁴ concerns the range of the greatest and smallest intervals according to what the voice can produce and what the ear can perceive. This is a subject mentioned in the first book of the *Harmonics* at 3.33–4.2 and treated fully at 13.33–15.13. It is not treated in the revised exposition in Book II.

All the evidence for theoretical works outside the *Harmonics* and *Rhythmics* in some way relates to those two treatises. The evidence included in the *Harmonics* itself refers to two earlier methods of harmonic science which Aristoxenus rejected in his own work: the empirical techniques employed by the harmonicists and the acoustic methods of the Pythagoreans. The four citations in Porphyry all concern material treated in the theoretical treatises. From these fragments on music theory we can see that although Aristoxenus maintains his emphasis on perception throughout much of his theoretical work, he is equally familiar with the rational methods and the numerical descriptions of Pythagorean musicology. While it is plain that Aristoxenus' reputation as a music theorist did not rest entirely on the *Harmonics*, it is also clear that the innovative work for which he is respected comes to its highest fruition there.

3. BEYOND MUSIC

Some brief comments are perhaps necessary on the fragments collected by Wehrli which do not refer to Aristoxenus' works on music. Many of these are merely passing references to Aristoxenus, and do not throw as much light on his philosophical capability as on his reputation as the principal authority for musicology in antiquity.¹⁴⁵ Some fragments, such as the entry in the *Suda* cited in the introduction, are the source for our scanty knowledge of Aristoxenus' life, his birth and early education in Tarentum and its Pythagorean influence, his sojourn in Mantinea, his coming to Athens and joining the school of Aristotle. Other fragments demonstrate that Aristoxenus was interested in areas other than music, such as biography, history, education, law and above all, Pythagoreanism, many of which are reflected in his musical writings.

There is evidence for extensive work on Pythagoras and his school covering such aspects as lifestyle and philosophy. Apart from the biographies of Pythagoras himself¹⁴⁶ and of Archytas,¹⁴⁷ titles referred to in the fragments include Πυθαγορικά ἀποφάσεις,¹⁴⁸ Περὶ Πυθαγορικοῦ βίου,¹⁴⁹ and Περὶ Πυθαγόρου καὶ τῶν γνωρίμων αὐτοῦ.¹⁵⁰ Although Aristoxenus must have moved away from Pythagorean teaching in order to join Aristotle's Lyceum, there is considerable evidence that he had great respect for his former school, and indeed the fragments include only positive comments about it. There is no indication in any of the passages of any motivation for the move and his disagreement with the mathematical calculations in the field of harmonics appears to be an exception to his general attitude towards the Pythagoreans. Aristoxenus' adherence to the theory of ethos further demonstrates his sympathy with ideas characteristic of the school, although this was a doctrine to which Aristotle also subscribed. Related to the Pythagorean concerns are fragments on law, education and politics which all indicate a generally conservative outlook.¹⁵¹ His Pythagorean inclination also appears to be expressed in the work *On Numbers*.¹⁵²

Another area in which Aristoxenus worked was biography, demonstrating again his willingness to work in various literary genres. Plutarch and Jerome refer to the fact that he wrote on the lives of men and attest his skill in the subject.¹⁵³ More specifically, there are several references to particular biographies in the fragments and—apart from those on Pythagoreans—they include Socrates,¹⁵⁴ Plato,¹⁵⁵ and Telestes,¹⁵⁶ in addition to works *On the Tragic Poets*, and *On Auletes*. Moreover, throughout the fragments there are references to historical figures: Sappho and Alcaeus,¹⁵⁷ Telesias of Thebes,¹⁵⁸ Hyagnis the Phrygian,¹⁵⁹ and Lasus, son of Chabrinus,¹⁶⁰ to name but a few, all put in an appearance. Aristoxenus'

knowledge of historical figures is obviously extensive, covering political figures and philosophers as well as poets, composers and musicians.

Yet in some cases the limitation of the biographical works is demonstrated in Aristoxenus' (notorious) inclination to allow personal prejudice to colour his presentation, as Eusebius notes in his *Preparation for the Gospel*.¹⁶¹ This is most obvious in his biographies of Socrates and Plato, both of whom he plainly dislikes despite the fact that he subscribes to many of Plato's views on education. On the other hand, Aristoxenus' high opinion of the Pythagoreans is apparent, and his praise of Archytas' self-discipline is contrasted with his blunt criticism of Socrates' excesses.¹⁶²

One thing often reported about Aristoxenus is his character. His penchant for *ad hominem* criticism is explicitly invoked by Cyril of Alexandria as a reason to doubt the worth of his judgement.¹⁶³ Cyril was particularly concerned with his treatment of Socrates, whom elsewhere Aristoxenus called uneducated, ignorant and undisciplined,¹⁶⁴ and to whose irascibility and passion¹⁶⁵ he had made disparaging reference. Furthermore, the ill-humour which seems to pervade his opinions on the intellectual leaders of fifth- and fourth-century Athens may well be the source of the claim, reported by Aelian, that he suffered from a generally unpleasant disposition.¹⁶⁶ This, however, seems to have had little impact on his reputation as a musical scholar and his judgement of musical matters remains for the most part unchallenged in antiquity.

Finally, there are a few tantalising fragments which indicate a much further range of subjects, demonstrating some medical interest. Aelian reports that Aristoxenus tells the story of a man who died from handling a snake although he had not been bitten,¹⁶⁷ while Apollonius relates Aristoxenus' cure for a quartan fever with a spiral plant.¹⁶⁸ This latter example also recalls Apollonius' relation of Aristoxenus using music as a healing power.¹⁶⁹ Despite this broader range, Aristoxenus seems to have little interest in the natural sciences which so occupied other Peripatetics such as Theophrastus.

Thus, much of Aristoxenus' work outside the field of music demonstrates his commitment to Pythagorean philosophy, not only in the works directly concerned with the school but also those relating to such matters as education and civic customs. While there are small pieces of evidence concerning other subjects beyond music, Aristoxenus' principal subjects seems to have been the praise of his first teachers.

CONCLUSION

The *Harmonics* and the *Rhythmics* show only one aspect of Aristoxenus' writings on musical subjects. The dry technical expositions of his theoretical

writings contrast with the anecdotal presentations of a variety of subjects on instruments, dance, music history and education.

Some of this work appears to be primarily concerned with the systematic gathering of information about music, names of instruments or dances, or the customs of geographically or chronologically different peoples. Yet these works are not simple compendia, often presuming in the reader some musical theoretical knowledge, and they frequently comment on the values or historical origin of certain practices.

On several occasions in the historical and educational works (for which we have the most evidence), the material included is similar to that of the *Harmonics* but treated in a different way, highlighting the non-technical aspects of musical structures. Much of this work seems to have been written before the theoretical treatises and shows some of Aristoxenus' thoughts in a nascent stage, demonstrating how he continued to examine and to develop his ideas on the issues of music which concerned him.

Aristoxenus' writings on music treat a wide range of subjects. Most of these works survive only in short citations, such as those on instruments and dance, but there is more substantial evidence for two Aristoxenian works which demonstrate the interest of the author in sociological and historical aspects of music. These are the *Peri Mousikes* and the unnamed treatise on musical education, the evidence for both of which is handed down to us through the Ps.-Plutarchean treatise *De Musica*. While in parts these works show less sophistication than Book II of the *Harmonics* through them Aristoxenus demonstrates his concern to organise the general investigation of music into distinct areas and to treat each area with the appropriate methodology. His debt to earlier theorists on sociological aspects of music as well as his independent ideas on music theory have contributed to the evolution of what may be called a total music system, the role of whose parts was clearly and precisely envisioned. It is in this aspect that the work of Aristoxenus appears at its most versatile.

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Musical Theory after Aristoxenus

INTRODUCTION

This final chapter is to explore how Aristoxenus' ideas developed in later antiquity and thereby to ascertain what role Aristoxenus can claim in the establishment of the science of musicology. Undoubtedly, Aristoxenus had the most influence in the field of theory, and not in the sociological or historical realm where his ideas were less innovative. In particular the methods developed in the *Harmonics* established a language and a programme for musicological discussion for the following centuries. Nonetheless, in spite of Aristoxenus' influence, a Pythagorean approach to harmonic science remained dominant throughout antiquity.

The chronological end point for this discussion is Boethius' *De Institutione Musica*, a work which can be seen to represent both the culmination of ancient Greek musical theory, and the means by which it was transmitted to the Middle Ages. While this is not the last work to be written with Greek theory as its model, and it is unfinished, Boethius' is the most comprehensive and substantial synthesis. It is a witness for the final dominance of Pythagorean mathematical concern in ancient musical discussion, and is critical of Aristoxenus' methodology and conclusions. Furthermore, it demonstrates the way in which some of Aristoxenus' empirical descriptions of musical structures were adopted, often unconsciously, into the mathematical exposition of musical science.

There are problems with attempting to map the evolution of musical investigation in antiquity. The period over which ancient Greek music theory develops spans more than a millennium from the first acoustic experiments of the Pythagoreans in the sixth century BCE to Boethius' treatise in the sixth century CE. Over such a period the precise meaning of particular technical

terms does not remain constant, trends in performance are not stable, while the relationship of performance practice to theoretical discussion is rarely certain. Some treatises are difficult to date and there are lengthy periods from which survive no musical treatises at all. In particular from the time of Aristoxenus' treatise in the fourth century BCE there is almost complete silence in musical theory until the appearances of several significant works in the second century CE. However, there is some fragmentary evidence concerning musical discussion during this period.

Despite these problems we can assert that two basic trends of music theory existed in a fairly sophisticated form after the appearance of Aristoxenus' *Harmonics*. The first developed from the earlier Pythagorean experiments in acoustics and attempted to associate musical science with arithmetical laws. This association was often extended to the explanation of a cosmological order based on significant musical numbers and patterns. The other, that of Aristoxenus himself, attempted to establish music as an independent and empirical science and was concerned with a systematic description of musical phenomena, primarily melody but often also rhythm. Later Pythagorean theory was able to use the methods established in Aristoxenus' treatise to expand its own program for musical investigation, adopting in particular his description of basic musical elements and systematic description of forms.

Chapters One and Two of this thesis sought to establish the nature of the various philosophical investigations into music which contributed to the creation of Aristoxenus' harmonic treatise; this chapter aims to define what impact the *Harmonics* had on subsequent musicology. In order to examine the influence of Aristoxenus on later musical theory, we must first establish the state of musicology in the fourth century BCE. Around the time of Aristoxenus' *Harmonics* appears the *Sectio Canonis* of Ps.-Euclid which generally represents the Pythagorean position of musical enquiry. Between and because of the treatises of Aristoxenus and Ps.-Euclid, the dichotomy of empirical and mathematical methods is established. It will remain, then, to investigate how Pythagorean musical theory reacted to the contribution of Aristoxenus, and how Aristoxenian theory attempted to maintain authority in the science of harmonics.

1. THE EUCLIDEAN *SECTIO CANONIS*

Pythagorean musical scholarship as it appears in the *Sectio Canonis* of Ps.-Euclid is a highly abstract affair. The treatise seeks to prove a series of twenty propositions¹ concerning the measurement of intervals through numerical ratios, and concludes, as the title suggests, with a division of the canon. This sets out the measurements for dividing a sonorous piece of string in order that

each of the pitches of a musical scale is produced. The date of the work is uncertain and so is its original form, particular problems being whether the introduction and the later propositions were subsequent additions. This is not the place to resolve these issues: for present purposes we will take it as a single text and presume it to have been written in the late fourth or early third century, as suggested by the attribution to Euclid.²

The treatise maintains a narrow focus on mathematical theorems and, despite its title, has no ambition to achieve an exhaustive set of calculations for musical structures. It is aimed at reasserting the validity of the numerical representation of intervals and the role of arithmetic in quantifying the division of musical space. In this respect, it is not unlikely that the *Sectio Canonis* was produced as a response to the Aristoxenian system which disregards the Pythagorean method and contradicts its results.³ Indeed specific propositions in the *Sectio Canonis* appear to be aimed at the *Harmonics* and correct Aristoxenus' estimates about interval size. To some extent, this need to confirm the Pythagorean musical programme indicates the impact of Aristoxenus' treatise, whose rigorous methodology demanded a response from the mathematicians in a way that the unsystematic assertions of the *harmonikoi* had not.

There is little similarity between the treatises. While Aristoxenus seeks to describe an empirical experience, the *Sectio Canonis* consists of a series of mathematical propositions. However, both Aristoxenus and Ps.-Euclid begin their discussions with the question of how the relationship of sound to movement should be applied to musical analysis. Aristoxenus, whose familiarity with the acoustic theories of his predecessors is undeniable, makes a statement at the beginning of Book II concerning the theories of mathematicians. He notes that their explanation of pitch is unempirical and depends on numerical theories.⁴

In response, the introduction of the Ps.-Euclidean treatise immediately establishes the connection of musical intervals to number ratios.

ὥστε ἐπειδὴ πάντες οἱ φθόγγοι γίνονται πληγῆς τινος γινομένης, πληγὴν δὲ ἀμήχανον γενέσθαι μὴ οὐχὶ κινήσεως πρότερον γενομένης, — τῶν δὲ κινήσεων αἱ μὲν πυκνότεραί εἰσιν, αἱ δὲ ἀραιότεραι, καὶ αἱ μὲν πυκνότεραι ὀξυτέρους ποιοῦσι τοὺς φθόγγους, αἱ δὲ ἀραιότεραι βαρυτέρους, — ἀναγκάϊον τοὺς μὲν ὀξυτέρους εἶναι, ἐπεὶ περ ἐκ πυκνοτέρων καὶ πλειόνων σύγκεινται κινήσεων, τοὺς δὲ βαρυτέρους ἐπεὶ περ ἐξ ἀραιωτέρων καὶ ἐλασσόνων σύγκεινται κινήσεων. ὥστε τοὺς μὲν ὀξυτέρους τοῦ δέοντος ἀνιεμένους ἀφαιρέσει κινήσεως τυγχάνειν τοῦ δέοντος, τοὺς δὲ βαρυτέρους ἐπιτεινομένους προσθέσει κινήσεως

τυγχάνειν τοῦ δέοντος. διόπερ ἐκ μορίων τοὺς φθόγγους συγκεῖσθαι φατέον, ἔπειδὴ προσθήσει καὶ ἀφαιρέσει τυγχάνουσι τοῦ δέοντος. πάντα δὲ τὰ ἐκ μορίων συγκείμενα ἀριθμοῦ λόγῳ λέγεται πρὸς ἄλληλα· ὥστε καὶ τοὺς φθόγγους ἀναγκαῖον ἐν ἀριθμοῦ λόγῳ λέγεσθαι πρὸς ἀλλήλους.

Thus since all sounds occur when some impact occurs, and since it is impossible for an impact to occur unless movement has occurred beforehand—and since of movements some are closer packed, others more widely spaced, those which are closer packed producing higher notes and those which are more widely spaced lower ones—it follows that some notes must be higher, since they are composed of closer packed and more numerous movements, and others lower, since they are composed of movements more widely spaced and less numerous. Hence notes that are higher than what is required are slackened by the subtraction of movement and so reach what is required, while those which are too low are tightened by the addition of movement, and so reach what is required. We must therefore assert that notes are composed of parts, since they attain what is required through addition and subtraction. Now all things that are composed of parts are spoken of in a ratio of number with respect to one another, so that notes, too, must be spoken of in a ratio of number to one another.⁵

Despite this introduction, the first nine propositions of the *Sectio Canonis* do not refer once to music or even to sound.⁶ They set out the proofs concerning ratios in mathematical terms and it is only in Proposition 10 that the author begins to relate these proofs to acoustical ideas. While the starting point for Aristoxenus' analysis is the definition of the note as the perceived resting of sound upon one pitch, Ps.-Euclid thus reasserts the numerical association of musical sound.

The author of the *Sectio Canonis* is clearly familiar with the musical calculations of earlier Pythagoreans, such as Archytas and Philolaus, because he uses their results.⁷ Yet he is selective in his choice of material, and does not attempt to compile the results of all Pythagorean investigation. When he comes to divide the canon, for instance, Ps.-Euclid uses the diatonic accepted by Plato and perhaps Philolaus, and by many later Pythagorean theorists (tone, tone, *diesis*), but does not mention the fact that Archytas had produced calculations for all three genera.⁸ Indeed, the treatise does not even provide a complete division in the diatonic for, although the calculation for the fixed note *nete synemmenon* is included, those for the movable notes of the *synemmenon* tetrachord are omitted. Furthermore, there is no attempt to quantify the chromatic tetrachord, and that of the enharmonic is incomplete. It seems likely

that the author's principal aim is to refute the validity of Aristoxenus' treatment of intervals, or perhaps that of the *harmonikoi*, rather than to provide an exhaustive enumeration of Pythagorean tetrachordal divisions.

This purpose is evidenced particularly in Ps.-Euclid's account of the enharmonic genus, which is related to his diatonic since it is defined by a diatone *lichanos* and a *pyknon* of 256:243. The position of the *parhypate* within the *pyknon* is not quantified: rather, the author notes and proves that αἱ παρυπάται καὶ αἱ τρίται οὐ διαιροῦσι τὸ πυκνὸν εἰς ἴσα.⁹ The point about this limited description is that, whatever the correct ratio division of the *pyknon* may be, Aristoxenus' proposed equal division is wrong. There is no need for Ps.-Euclid to specify all the intervals which make up the tetrachord as it is sufficient for him to discredit Aristoxenus. For his part, Aristoxenus had made no attempt to prove that the *pyknon* can be equally divided, merely stating that this is evident from the division of the enharmonic (52.11–13).

This assertion about the equal division of intervals is an important argument against Aristoxenus' perception of musical space. The proof that the *pyknon* of the enharmonic is not divided equally is dependent on an earlier proposition in the treatise which Ps.-Euclid draws from Archytas, and many of the points which the author seeks to establish refer back to this proposition. This is Proposition 3 (152.1 ff.), which disproves the possibility of equal division of epimoric intervals and is one of the principal tenets of Pythagorean musical theory:¹⁰ ἐπιμορίου διαστήματος οὐδεὶς μέσος, οὔτε εἰς οὔτε πλείους ἀνάλογον ἔμπεσείται ἀριθμός.¹¹ If this proposition is accepted then many of the melodic intervals approved by Aristoxenus are invalid.¹² Most importantly it undermines Aristoxenus' entire understanding of the arrangement and division of musical systems, in particular his divisions of the tetrachord.

Other propositions in the treatise exemplify the mathematical problems of the *Harmonics* and three of them specifically contradict claims made therein about musical *systemata*. The first of these concerns the size of the octave: τὸ διὰ πασῶν ἔλαττον ἢ ἕξ τόνων.¹³ Aristoxenus does not ever attempt to prove, or even to specify that the octave consists of six tones, but this is easily inferred from the discussion of concords in Book II the *Harmonics*. He notes that the sum of the first two concords is an octave (45.15), a statement also made in the *Sectio Canonis* (Proposition 6, 154.15–17). The two treatises also agree that the amount by which the fifth is greater than the fourth is a tone (45.33–46.1 and Proposition 8, 156.12–14). However, Aristoxenus asserts that a fourth equals two and a half tones which can be added to a fifth of three and a half tones to produce an octave of six tones. The

author of the *Sectio Canonis* on the other hand proves that an octave is less than six tones by an interval of 531441: 524288 (24 cents).

The second proposition to contradict Aristoxenus concerns the sizes of the fourth and the fifth. τὸ διὰ τεσσάρων ἔλαττον δύο τόνων καὶ ἡμιτόνιου, καὶ τὸ διὰ πέντε ἔλαττον τριῶν τόνων καὶ ἡμιτόνιου.¹⁴ If an octave is less than six tones (which has been proved), and if the fifth is three and a half tones, the fourth must be less than two and a half tones. However, throughout the first two books of his treatise, Aristoxenus has asserted that the fourth equals exactly two and a half tones, and has based all his descriptions of musical scales on this 'fact.' At the end of Book II of the *Harmonics* he sets out an elaborate construction, based on the assessment of a series of consonances by ear, through which a student may judge for himself whether this estimate of the size of the fourth is correct (56.14–58.6).¹⁵ This suggests that Aristoxenus felt the need to reiterate his position against the Pythagorean calculations which contradict it.¹⁶

Finally, the author states a fundamental problem of Aristoxenus' theory in musical terms: ὁ τόνος οὐ διαιρεθήσεται εἰς δύο ἴσα οὔτε εἰς πλείω.¹⁷ This has already been proven through Proposition 3, relating to the impossibility of the equal division of epimoric intervals. It is stated again in this way to emphasise the implications of the statement—that Aristoxenus' terminology for musical division and his account of "melodic" intervals is erroneous. For Aristoxenus there is no question that it was not possible to divide the tone in such a way (and, according to him, why should there be?), so in Books I and II he enumerates the divisions of the tone which are melodic: the semitone, the third-tone and the quarter-tone (21.20–31 and 46.3–8).

Together, these propositions support the notion that the *Sectio Canonis* is a response to Aristoxenus, since the author does not suggest his own tetrachordal divisions according to each genus, but seems concerned above all to disprove the validity of Aristoxenian claims and techniques. The *Sectio Canonis* systematically enumerates the arithmetical proofs relating to ratios involved in musical pitch and their arrangement. Although the calculations of the treatise are valid,¹⁸ and successfully disprove the divisions asserted by Aristoxenus, the work does not answer—and does not even attempt to answer—the essential thesis proposed by the *Harmonics*, that music is understood not through number ratios but in the context of ordered scale systems. In the same way Aristoxenus does not attempt to refute the Pythagoreans directly, merely arguing for his own methodology while calling theirs totally extraneous (ἄλλοτριώτατοι λόγοι, 32.26).

Despite, or perhaps because of, their separate paths Aristoxenus' *Harmonics* and the Ps.-Euclidean *Sectio Canonis* set the programme of musical

investigation for the following centuries. The difference between them is primarily one of methodology, but it has broader implications for the definition of the science of harmonics and what it should include. Both treatises concern the nature of musical sound and seek a method to describe its structures. The Aristoxenian treatise, on the one hand, aspires to depict music independently from other factors, representing music as it is perceived and understood by the listener and presenting a systematic exposition of its structures. The *Sectio Canonis*, on the other hand, seeks proofs for relating musical intervals to particular numerical ratios based on the extra-musical evidence of arithmetic. Many later authors attempted to include both methodologies into a coherent work on music, with varying levels of success.

2. THE DEVELOPMENT OF PYTHAGOREAN AND ARISTOXENIAN THEORY

In this section and the ones that follow, we shall trace briefly the major figures and works in the development of Aristoxenian and Pythagorean musical theory which followed the appearance of the *Harmonics* and the *Sectio Canonis*. It must be emphasised that the term Pythagorean is being used to reflect an approach to musical science and not a general philosophical stance. It means in this context, the adoption of the musical methodology started by Pythagoreans such as Philolaus and Archytas which highlighted the mathematical relationships between musical pitches. Later theorists who adopted the methods and expression of Archytas and Philolaus (such as Plato, Eratosthenes, and Ptolemy) are to be understood as Pythagorean only in a musical theoretical context. Even the elements of musical theory incorporating a cosmological emphasis such as in Plato, and later in Ptolemy and Aristides Quintilianus, can only be said to have their origins in Pythagorean thought.

In the subsequent centuries musicological methodology naturally continued to be reproduced, analysed and debated. Although no complete treatise survives from the period of Aristoxenus and Ps.-Euclid until the second century CE, there are some fragments which indicate how musical thought had developed in the meantime. They give us an idea of how an essentially Pythagorean understanding of musical structures recovered from the blow given to it by Aristoxenus' treatise, principally by assimilating Aristoxenian empirical descriptions into its framework.

The dependence on arithmetic shown in the Ps.-Euclid is not the only area of concern in music for Pythagorean theorists and a significant difference in scope is an important distinction between the two methods. While Aristoxenus tried to limit his discussion to musical experience, the Pythagoreans, as Aristotle had noted in the *Metaphysics*,¹⁹ wished to grant to

the numerical order of musical structures a cosmological significance. Side by side with this process, it should be noted that we have no evidence that Ps.-Euclid attempted to relate musicological description to a broader cosmological framework. Increased specialisation, probably necessitated by the delimitation of Aristoxenus' work, was an important feature in the growth of Pythagorean musical theory.

However, Aristoxenus himself may not have been immune from considerations external to music. His ability to develop his conception of musical space may have been influenced by the developing science of geometry, in which irrational figures could now be expressed.²⁰ Similarly, some of Aristoxenus' tetrachordal divisions are so subtly distinguished (as Ptolemy later noted²¹) that there appears to be more of a concern to describe a balanced set of structures than to represent perceptibly different musical forms.²² Therefore, although Aristoxenus does not depend on the language or logic of another science, it can be argued that he is not entirely faithful to the task of maintaining an independent account of musical structures. It must also be acknowledged that an imperfect independence from external factors is frankly not as important as the fact that Aristoxenus' work offers a significant opportunity for the development of musicological expression.

Incidentally, the Pythagorean and Aristoxenian methods were not the only approaches to describing musical phenomena in the fourth century. There were, of course, the demonstrations of the *harmonikoi*. Yet another alternative is suggested by Theophrastus' treatise *On Music*, cited by Porphyry,²³ which argues against both Pythagorean number ratios and empirical interval measurement as methods for pitch comparison, and suggests that the difference between notes is qualitative, depending on different shapes of sound. Unfortunately the treatise does not survive complete, and it is unknown whether Theophrastus developed this theory further. In addition, Aristoxenus himself mentions other methods of musical enquiry including those dependent on notation and on instruments.²⁴ Over the next few centuries, however, it is the Aristoxenian and Pythagorean harmonic methods which, perhaps because of their potential for development, become dominant.

In general, later theorists did not accept Aristoxenus' assertion that Pythagorean methodology was irrelevant to the science of harmonics, but they also did not reject Aristoxenus' empirical descriptions of harmonic elements. The resulting work is not always coherent, but there is evidence that the greater potential for music theory produced by the combination of methods began to be exploited in the period before the second century CE.

The evidence of musical investigation which survives from this intermediary period exists mostly in citations by later commentators.²⁵ Theon of

Smyrna's *Mathematics Useful for Reading Plato* preserves the work of Thrasyllus and Adrastus, which exemplifies the absorption of Aristoxenus' theories into an essentially Pythagorean method. Porphyry's *Commentary on Ptolemy's Harmonics* cites, among other works, the comments of Didymus from a work entitled *On the Difference between Aristoxenians and Pythagoreans* and of an otherwise unknown female theorist Ptolemais. Further evidence from this period comes in the form of Eratosthenes' and Didymus' tetrachordal divisions preserved in Ptolemy's *Harmonics*.

From around the beginning of the second century CE, there was a renewal of activity in musical theory and some important treatises appear. Cleonides' *Eisagoge Harmonike* is an epitome of the *Harmonics* of Aristoxenus, and valuable primarily on account of the fact that it includes sections which are lost from the earlier treatise. Yet it is so cursory and involved in so little methodological discussion compared to its original that it is less enlightening than might be expected. In fact, Cleonides reduces Aristoxenus' descriptions of musical structures to their barest outline, and omits the methodological discussions and comments concerning the failures of earlier theorists.

Nicomachus' *Enchiridion* is quite different. It is not merely a summary of the musical ideas of a single author, but shows influences from a range of sources. A considerable portion of the work traces the historical development of acoustics and Pythagorean harmonics and, while Pythagorean concerns are primary, the author has also adopted some ideas from Aristoxenus. The treatise is not of the highest standard and there are numerous mistakes and contradictions. This is in part probably owing to the fact that Nicomachus wrote it while on a journey, which he acknowledges at the beginning: ἐγὼ τε ἄλλως ὑπὸ τῆς ὁδοιπορικῆς ἀκαταστασίας καὶ συνεπιξέως οὐκ ἀκυμάντως τοῦ λόγου φροντίδι καὶ διανοίᾳ δυνατός εἰμι τῇ περὶ τούτων ἐπιβαλέσθαι διδασκαλίᾳ μετὰ τῆς προσηκούσης σαφηνείας σχολαίου μάλιστα καὶ ἀπερισπάστου δεομένης καιροῦ τε καὶ συλλογισμοῦ.²⁶ He promises to its addressee a more detailed work and there is a reasonable argument to be made for the suggestion that this more thorough treatise was completed and the source for the first four books of Boethius' *De Institutione Musica*.²⁷ Some fragments attributable to Nicomachus (*Nicomachean Excerpts*) may also have formed part of this later work.

Plato's discussion of the division of the world soul in the *Timaeus* provides the foundation for further presentations of mostly Pythagorean harmonic theory.²⁸ Plutarch's first or second century essay *De animae procreatione in Timaeo* focuses narrowly on this passage, while the later works of Calcidius and Proclus include harmonic discussion in their commentaries on the *Timaeus* as a whole.²⁹ All three focus in particular on the mathematical

calculations involved in Plato's division of the world soul and their relationship to musical scales.

Two particularly important treatises from this period, since they offer the most extensive treatments of the subject, are those of Ptolemy and Aristides Quintilianus. Between them they represent the later development of Pythagorean and Aristoxenian methods and demonstrate the cross-fertilisation between the two. They are also responsible for much of the theory which was transmitted into the Middle Ages: Aristides Quintilianus was one of the sources for Martianus Capella's book on music, while Ptolemy provided Boethius with some elements of his methodological discussion.

Ptolemy's *Harmonics* (second century CE) is not just a source for earlier material, for it is a sophisticated synthesis of previous scholarship. It combines the mathematical calculations developed from theorists using Pythagorean methods (such as Archytas, Ps.-Euclid, Eratosthenes and Didymus) with the systematic exposition of musical structures and methodological analysis pioneered by Aristoxenus. Yet Ptolemy does not associate himself with either of these schools, and instead criticises both of them. As a whole, his work tends towards Pythagoreanism, not merely for the acoustic priorities promoted by his constant reference to the canon, but also for the greater cosmological and ethical agenda to which he subscribes, particularly in his final book.³⁰

The treatise of Aristides Quintilianus is impossible to date precisely and may belong anywhere between the second and fourth centuries CE.³¹ Its more general title of *De musica* acknowledges the broader range of subjects included in the treatise, and it attempts the encyclopaedic presentation of musical knowledge incorporated into three books. The first is an Aristoxenian presentation of the parts of music: melody, rhythm and metre. The second concerns musical education and ethos, and the final book is a Pythagorean exposition of musically significant numbers and their cosmological associations.

Other harmonic treatises in Greek which survive from the Roman empire contain little new material and increasingly less methodological discussion. The *Harmonic Introduction* (second or third century) of Gaudentius is essentially an Aristoxenian exposition into which is inserted a Pythagorean passage on the ratios of intervals. A systematic presentation of musical notation but very little else is contained in Alypius' *Introduction to Music* (Εἰσαγωγή τῇ Μουσικῇ, third or fourth century), while Bacchius Geron's *Introduction to the Art of Music* (circa fourth century) is a catechism presenting simple Aristoxenian ideas on melody and rhythm.

There are several later authors who discuss music as part of a more general work. Martianus Capella's *De nuptiis Philologiae et Mercuri* (early fifth century) consists of nine books, two introductory and then one on each of the

seven liberal arts; Cassiodorus' *Institutiones* (sixth century) also treats the seven liberal arts and its chapter on music is a simple résumé of Aristoxenian theory. The encyclopaedic *Etymologies* of Isidore of Seville contains a short section on music including a few notes on musical elements in the Aristoxenian tradition, and some on instruments and on musical numbers. The fact that these three works are in Latin rather than Greek ensured that at least some representation of Aristoxenus' empirical theory was transmitted into Western Europe in the Middle Ages.

Unfortunately, most Aristoxenian musical theory in these Latin versions is too abbreviated to compete with the intellectually more challenging (and rewarding) accounts of the Pythagorean theory as represented by Boethius. His *De Institutione Musica* draws heavily on the treatises of Nicomachus and Ptolemy and, unlike the majority of later treatises, does not avoid discussion of the methodology of the Pythagorean and Aristoxenian schools.³² Although his exposition is undeniably Pythagorean, elements of Aristoxenus' programme of harmonics are still clearly evident.

Over a thousand years after the appearance of the *Harmonics*, arguments attempting to answer Aristoxenus were still being produced. This suggests that the Pythagorean/Aristoxenian dichotomy had become as much a part of the tradition of harmonic science as the statement that the octave is the sum of the first two concords. It also indicates that Aristoxenus' account of harmonic space is not overruled by the mathematical proofs of the Pythagoreans and that, although his interval evaluation is refutable, his description of how music is perceived is not. The problem of the contradiction between Aristoxenus' stubborn refusal to accept mathematical truth in this context and his illumination of musical structures was never resolved in antiquity. Indeed, the question posed to the Pythagoreans by Aristoxenus' *Harmonics* could not be answered.

In the following sections we will attempt to analyse the interplay of Pythagorean and Aristoxenian thought in later treatises. Often the adoption by Pythagorean theorists of Aristoxenian language and method is apparently unconscious, particularly in the description of musical elements and scale systems. Similarly, some authors who present a primarily Aristoxenian exposition include the basic mathematical ratios of intervals without commenting on their significance in an empirical account of melody. Sometimes a deliberate opposition is set up between the two methods, but more often there is a complete lack of methodological discussion.

The evidence in the following sections demonstrates the contribution of Aristoxenus to music theory. His description of the nature of musical sound, his division of melody into separate, empirically-described elements, and his

systematic enumeration of musical forms all contribute to the impact of his writings on the subject. General ideas about the definition and scope of musical science were assumed by later writers as well as the need to consider the relative resources of reason and perception. Different aspects of Aristoxenian methodology are adopted by various theorists, but there is often neither acknowledgement of sources for later theory, nor any clear distinction between these two fundamentally different approaches.

3. THE DEFINITION OF HARMONICS

Aristoxenus' definition of the science of harmonics in Book II of the treatise focuses on melody. ἔστι δὴ τὸ μὲν ὅλον ἡμῖν <ῆ> θεωρία περὶ μέλους παντὸς μουσικοῦ τοῦ γιγνομένου ἐν φωνῇ τε καὶ ὀργάνοις. ἀνάγεται δ' ἡ πραγματεία εἰς δύο, εἰς τε τὴν ἀκοὴν καὶ εἰς τὴν διάνοιαν.³³ This definition is adopted by many later theorists, reconfirming the new status of harmonics as an independent science able to be described in empirical terms. The identification of the different roles of reason and perception which occurs in the sentence immediately following Aristoxenus' definition is also an issue taken up in various ways by several subsequent authors.

Aristides Quintilianus' initial definition of musical science is very similar to that of his predecessor: μουσική ἐστὶν ἐπιστήμη μέλους καὶ τῶν περὶ μέλος συμβαινόντων.³⁴ After noting some other definitions he expands: ἐπιστήμη μὲν οὖν ἐστὶν, ἣ γνῶσις ἀσφαλὲς ὑπάρχει καὶ ἀδιάπτωτος· τῶν γὰρ ἐν αὐτῇ λεγομένων ἢ ὡς προβλημάτων ἢ ὡς ἀποτελεσμάτων οὐκ ἂν ποτε μεταβολὴν ἢ ἀλλοίωσιν ἐπιδέξαιτο. καὶ μὴν καὶ τέχνην αὐτὴν εὐλόγως ἂν ἀποκαλοῖμεν· σύστημα τε γὰρ ἐστὶν ἐκ καταλήψεων, καὶ τούτων ἐπ' ἀκριβὲς ἡσκημένων.³⁵ Aristides has maintained the ambition of Aristoxenus apparent in Book III of the *Harmonics*, where he attempts to set out harmonics as an axiomatic science on the presumption that the arrangement of musical pitch is absolute rather than an arbitrary human construct.³⁶ However, despite the hints at axiomatic treatment given by Aristides' references to *problemata* and *apotelesmata*, nothing in his own treatise is presented in axiomatic form.

Conversely, the acoustic emphasis of the opening sentence of Ptolemy's *Harmonics* displays the Pythagoreanism favoured in his treatise: ἀρμονική ἐστὶ δύναμις καταληπτική τῶν ἐν τοῖς ψόφοις περὶ τὸ ὄξύ καὶ τὸ βαρὺ διαφορῶν, ψόφος δὲ πάθος ἀέρος πλησσομένου—τὸ πρῶτον καὶ γενικώτατον τῶν ἀκουστῶν—καὶ κριτήρια μὲν ἀρμονίας ἀκοὴ καὶ λόγος, οὐ κατὰ τὸν αὐτὸν δὲ τρόπον.³⁷ This is a very abstract definition, focusing on the physical nature of sound rather than the perception of

melody. Yet the fact that the science is described as the “power that grasps” (δύναμις καταληπτική) something, reflects Aristoxenus’ discussions of how the mind makes sense of melody through hearing and reason.

It is significant that the definitions of Ptolemy, Aristides Quintilianus and Aristoxenus all mention the necessity to balance hearing and reason. Didymus and Ptolemais in their discussions of musical treatments also focus on this balance, providing a valuable exception to the general lack of discussion concerning methodology. Didymus’ presentation of the difference between the Pythagoreans and Aristoxenians sets up two extremes of musical methodology, the instrumentalists and the Pythagoreans, relying respectively on perception and reason. Between them he places Aristoxenus: οὐ γὰρ εἶναι λογικὸν μάθημα μόνον τὴν μουσικὴν, ἀλλ’ ἅμα αἰσθητὸν καὶ λογικόν, ὅθεν ἀναγκαῖον εἶναι μὴ ἀπολείπεσθαι θατέρου τὸν γνησίως πραγματευόμενον, καὶ προηγούμενον τιθέναι τὸ τῇ αἰσθήσει φαινόμενον, εἴπερ ἐντεῦθεν ἔστιν ἀρκτέον τῷ λόγῳ.³⁸ Didymus may speak favourably of the Aristoxenian approach, but his tetrachordal divisions (cited by Ptolemy) are expressed in Pythagorean terms and show sophisticated arithmetical calculation. Ptolemais in her *Pythagorean Elements of Music* also comments on the different priorities of reason and perception held by instrumentalists, Pythagoreans (*kanonikoi* in particular) and Aristoxenians.³⁹ Despite her title it is Aristoxenus’ methodology which she appears to favour, and she criticises the Pythagoreans for using perception to establish the ratios of the fundamental concords and then rejecting its evidence.

Clearly the various claims about judicious use of these resources, reason and perception, do not result in the same method in all theorists. Aristoxenus claims that perception is needed to establish the size of intervals, and reason to place them in the dynamic context of a scale. The use of perception for him refers only to the judgement of the trained ear with no comparison to a standard measured by other means. On the other hand, Aristides notes the importance of perception in his definition of harmonics, but undertakes little methodological discussion of its role. For Ptolemy, the role of perception takes place in the use of acoustic experiments, a tradition going back to the earlier experiments of such theorists as Hippasos and Lasus of Hermione—if not Pythagoras himself. Ptolemy declares his dependence on the use of the canon from the start of the treatise and constantly refers to the practical experiments which verify the soundness of his mathematical calculations.⁴⁰

An important part of Aristoxenus’ exposition of the science of harmonics is its separation from other disciplines. Apart from the rejection of acoustic and arithmetical sciences in the study of harmonics, Aristoxenus also separates from it the sciences of rhythm, metre and instruments (32.4–9) and the no-

tation of melodies (39.4 ff.). This strict division of disciplines is not followed in quite the same way by later Aristoxenian theorists. The first book of Aristides Quintilianus' treatise presents an almost purely Aristoxenian style of exposition of melody, but does not respect the limitations of the topic with the same rigor as Aristoxenus. He incorporates a discussion of notation into his treatment of harmonics, which is immediately followed by his accounts of rhythm and metre. Book II concerns the application of musical theory and education, and the final book contains an account of the numerical ratios of intervals, discusses natural science and arithmetic and treats cosmological and musical relationships. The inclusion of a cosmological exposition in Book III betrays Aristides Quintilianus' Pythagorean inclinations.

Other apparently Aristoxenian theorists also include extraneous material. A summary exposition of rhythm occurs (though admittedly in a separate self-contained section) in Bacchius Geron's *Introduction to the Art of Music* (93 ff.) as well as in Martianus Capella's book on music (IX 967 ff.). Capella's treatise incorporates numerical ratios into the discussion of consonant intervals and the tone, but not into the discussion of the smaller intervals (IX 951–953). Inserted into the middle of Gaudentius' essentially Aristoxenian treatise is an extended exposition of the ratios of intervals including the erroneous tale of Pythagoras and the hammers and calculations for the division of the canon in the diatonic and chromatic genera. While a discussion on rhythm is not outside the realm of musical phenomena, and indeed Aristoxenus' own treatise on rhythm is very similar in style to the *Harmonics*, inclusion of the Pythagorean ratios deliberately exceeds the boundaries of Aristoxenus' empirical science. Moreover, these limits are further transgressed in the description of musical notation, which also appears in the work of Bacchius Geron, Alypius (who does not include much else) and Aristides Quintilianus.

Another aspect included in the work of several later theorists concerns the historical development of musical scales. Aristoxenus excluded this—for the most part—from his *Harmonics* but it was a subject he treated elsewhere, as is evident in the accounts of the *De Musica* of Ps.-Plutarch. The evolution of musical structures forms part of the treatise of Aristides Quintilianus as he includes an irregular set of scales which he claims to be the *systemata* referred to by Plato in the *Republic* (19.3).⁴¹ Similarly, Nicomachus presents an historical discussion of musical structures and harmonic discoveries, including those of Pythagoras, Plato and Philolaus. He attributes to Pythagoras the addition to the older heptachord system of an eighth note which expanded the scale from two conjunct tetrachords to two disjunct tetrachords extended over

an octave. Like his source (probably Nicomachus), Boethius' exposition includes an extended description of the development of scale forms.

Thus, Aristoxenus' careful delineation of the boundaries of harmonic science is completely disregarded by the Pythagorean treatments of the subject, which extended its limits not merely to other musical phenomena but also to cosmological and ethical systems. As Aristotle noted in the *Metaphysics*, the correspondence of musical sounds to numerical relations leads the Pythagorean thinkers to attempt to establish a universal framework of significant numbers, and the broader perspective naturally follows. Once Aristoxenus had established the systematisation of a whole series of musical structures, the consonances, the genera, species of fourth, fifth and octave and *harmonia* (which we know through Cleonides formed part of Aristoxenus' treatise), these structures consequently provide ample opportunity for comparison with a wide range of cosmological and ethical speculation. Accordingly, a simple cosmological discussion appears in Nicomachus who associates each of the notes of two conjunct tetrachords with a planet (Ch. 3, 241.1 ff.). Boethius also recites a similar note-planet association (I 27), and more extensively, the third books of the treatises of both Aristides Quintilianus and Ptolemy treat cosmological matters.

Ptolemy provides a more elaborate example of the way in which Aristoxenus' systematisation was exploited. The fourth chapter of Book III begins the final phase of his treatise, the detailed parallels perceived between the systems of music and those of the human soul and the heavens: ὅτι ἡ τοῦ ἡρμοσμένου δύναμις πᾶσι μὲν τοῖς τελειότεροις τὰς φύσεις ἐνυπάρχει, καταφαίνεται δὲ μάλιστα διὰ τε τῶν ἀνθρωπίνων ψυχῶν καὶ τῶν οὐρανίων φορῶν.⁴² Subjects include the comparison of the genera of music with the genera of the theoretical and practical primary virtues. τὸ μὲν οὖν ἐναρμόνιον τῷ τε φυσικῷ καὶ τῷ ἠθικῷ παραβλήτεον διὰ τὴν κοινὴν παρὰ τᾶλλα τοῦ μεγέθους ἐλάττωσιν, τὸ δὲ διατονικὸν τῷ θεολογικῷ καὶ τῷ πολιτικῷ διὰ τὴν τῆς τάξεως καὶ τῆς μεγαλειότητος ὁμοιότητα, τὸ δὲ χρωματικὸν τῷ τε μαθηματικῷ καὶ τῷ οἰκονομικῷ διὰ τὴν τῆς πρὸς τὰ ἄκρα μεσότητος κοινότητα.⁴³ Further propositions about harmonics and the zodiac are assisted by the dominance of the number twelve in both systems, and the cyclical nature of the heavens and such constructs as the species of the octave.⁴⁴

Similarly, Aristoxenus' restriction of the subject is not maintained by his successors, and this element of his treatise is not acknowledged by later compilers and commentators. Authors after Aristoxenus did not express the differences between Aristoxenian and Pythagorean methods in relation to the presence or absence of a cosmological agenda, or in relation to the inclusion

of a discussion on rhythm and metre, but in a balance of reason and perception. Their expositions demonstrate an understanding that reason in harmonics includes the representation of intervals as numerical ratios, while a dependence on perception refers to the use of an empirical terminology independent of arithmetical calculation.

4. THE ELEMENTS OF HARMONICS

Having defined the limitations of his topic, Aristoxenus is clear about what is included in the science of harmonics. In Book II he lists the seven parts which must be treated: genera, intervals, notes, *systemata*, *tonoi*, modulation and melodic composition. The convenience of this list accounts for its use by his inheritors Cleonides (179.7–9), Aristides Quintilianus (7.10–12), Gaudentius (327.5–8), and Martianus Capella (IX 938).

Interestingly, Aristoxenus' list of musical elements in Book II gives priority to genera and intervals over notes. This reflects the importance he places on the system as a whole and on the dynamic nature of notes. It is a concern rarely reflected in later imitations of Aristoxenian theory, where the majority of theorists who adopt his list of parts place them in the following order: notes, intervals, genera, *systemata*, *tonoi*, modulation and *melopoiia*.

This arrangement mirrors a geometric expression of physical space which progresses from point to line, plane and solid. As the musical equivalent of a geometric point, the note is of no substance and it is indivisible. A potentially infinite number of them can be placed within any interval in the same way as a potentially infinite number of points can exist on a line. Furthermore, as a point can be placed in context by a line connecting it to another point, an isolated note can be given significance by its relationship with another note and the formation of an interval. The musical representation is given further depth with the revelation of the rest of the tetrachord or scale as a structure increases its complexity in two or three dimensions.

Interestingly, this precedence of the note and its similarity with a geometric point indicates in the later descriptions of musical evidence a move away from Aristotle's definition of the unit of melody as the *diesis* (e.g. *Metaphysics* 1016b18–24, or *Posterior Analytics* 84b37–9), which can be used as a measure for all intervals. In this way while Aristotle's measure is arithmetical, and in accordance with the unit, or the Pythagorean monad, the definition of the element of melodic sound has been redirected through Aristoxenus' influence to a geometrical concept.

Yet the main contribution which Aristoxenus makes to understanding of the elements of music, that is of the material out of which music is formed, is drawn from a passage in Book I of the treatise. The discussion of the movement

of the voice which Aristoxenus excised from the second edition of his *Harmonics* is included in some form in almost all later discussions of the subject.

Our programme for discussion will follow the first five parts of harmonics and how Aristoxenus' understanding of each of them developed in later theorists. The final two parts of harmonics, modulation and *melopoiia*, are almost entirely absent from what survives of Aristoxenus' work, and the treatment of Cleonides is so summary as to be virtually useless. While Aristides Quintilianus' exposition of modulation and *melopoiia* is less summary than that of Cleonides, it still gives us little idea about Aristoxenus' methodological approach to the subject. Aristides does give definitions of each topic which are likely to have their origin in Aristoxenus.⁴⁵ However, in the light of the distance between Aristides' and Aristoxenus' discussions of *dynamis* amongst other things, there is little foundation to consider their relationship with, and development from, the original. Therefore, after the preliminary section on the movement of the voice, the following treatment of the later development of Aristoxenian theory will be limited to notes, intervals, genera, *systemata* and *tonoi*.

4a. The Movement of the Voice

As we discussed in Chapter Three, Aristoxenus spends considerable time in Book I discussing the movement of the voice with regard to space (τόπος) (8.13–15.13), a discussion which he omits from Book II. He makes the distinction between continuous and intervallic sound, then defines height (ὀξύτης) and depth (βαρύτης) as the result of the tension (ἐπίτασις) and relaxation (ἀνεσις) of sound, and pitch (τάσις) as its stability. Aristoxenus also establishes a formula for the potential maximum and minimum size of intervals in relation to the voice's production and the ear's perception. These ideas re-appear in various forms right through the musicology of antiquity to Boethius and often function as a prelude to a theorist's definition of the note.

Cleonides' treatment of the movement of the voice includes an interesting variation of Aristoxenus' description. Like the rest of his work, the account is much compressed, but nevertheless covers the essential definition of the continuous movement of the voice in speech, intervallic movement in melody, and the five terms relating to pitch. At 180.12 he attributes to the speaking voice the characteristic of making its tensions and relaxations imperceptibly (ἀφανῶς). Aristoxenus had judged this a characteristic of the singing voice, ἐπειδὴ τὸν μὲν τοῦ διαστήματος τόπον ὃν διεξέρχεται ὅτε μὲν ἀνιεμένη ὅτε δ' ἐπιτεινομένη λανθάνειν αὐτὴν δεῖ διεξιούσαν.⁴⁶

Similarly, Aristides Quintilianus, clearly dependent on Cleonides, adopts this reversal: συνεχῆς μὲν οὖν ἔστι φωνὴ ἢ τὰς τε ἀνέσεις καὶ τὰς ἐπιτάσεις λεληθότως διὰ τι τάχος ποιούμενη, διαστηματική δὲ ἢ τὰς μὲν τάσεις φανεράς ἔχουσα, τὰ δὲ τούτων μεταξὺ λεληθότα.⁴⁷ Aristides, as Boethius does later, unnecessarily includes a third and intermediate category of vocal movement, for the reading of poetry. In addition, Aristides Quintilianus' discussion on the movement of the voice (5.20 ff.) distinguishes between simple movement (resting on a single pitch) and non-simple movement, a distinction referring to Pythagorean acoustic theory, before he divides non-simple movement using the Aristoxenian differentiation between continuous and intervallic movement respectively of speech and melody. In this way, Aristoxenian ideas are confused with contradictory ones.⁴⁸

The more overtly Pythagorean authors of this discussion are equally dependent on Aristoxenus, but also emphasise the numerical interpretation of intervals. Employing equivalent terminology to Aristides Quintilianus, Ptolemy distinguishes between the sounds of speech and melody in order to highlight the numerical connection to pitch. He refers to sounds as either "equal-toned" (ἰσότονοι, on the same pitch) or "unequal-toned" (ἀνισότονοι, of varying pitch), and reiterates the numerical definition of intervals which he employs. Movement between the unequal-tones sounds is distinguished as either continuous (συνεχεῖς) or divided (διωρισμένοι), and the latter belongs to harmonics τοῖς μὲν πέρασι τῶν ἰσοτονιῶν ὀριζόμενοι, περαμετρούμενοι δὲ ταῖς τάξεσι τῶν ὑπεροχῶν.⁴⁹ Finally, equal-toned sounds are labelled "notes" (φθόγγοι). Yet, despite the similarity of his account to Aristoxenus', Ptolemy does not acknowledge him as the initiator of this interpretation of sound.

Ptolemy also draws from Aristoxenus the idea of the potential extent of the height and depth of sound. He argues that they are unlimited in potential but limited in actuality: ἐνεργεῖα δὲ πεπερασμένας ὥσπερ καὶ τὰς τῶν μεγεθῶν, εἶναί τε δύο τούτων ὅρους, τὸν μὲν αὐτῶν τῶν ψόφων ἴδιον, τὸν δὲ τῆς ἀκοῆς, καὶ μείζονα τοῦτον ἐκείνου.⁵⁰ Even though he appears to be referring to pitch absolutely and not, as Aristoxenus did, to the maximum and minimum sizes of intervals, his idea is consistent with the recognition of Aristoxenus that the number of possible concords is only limited by human capacity (21.12–18).⁵¹

The unacknowledged adoption of Aristoxenian descriptions of musical phenomena appears in other Pythagorean sources. Nicomachus' account in Chapter 2 of the *Enchiridion* of continuous and intervallic sound clearly draws on Aristoxenus even though Nicomachus attributes the idea, surprisingly, to the Pythagoreans.⁵² Later in the chapter, Nicomachus presents a confusing

account of Aristoxenus' discussion of the limitation of human perception and the range of the voice. Again, he does not acknowledge Aristoxenus as his source when he notes that human perception and range of the voice is limited, and he fails to distinguish clearly between pitch and volume.

Finally, Boethius confirms the extensive but unappreciated contribution of Aristoxenus in the elemental description of musical sound. He, too, adopts the distinction between continuous and intervallic movement. *Omnis vox aut συνεχής est, quae continua, aut διαστηματική, quae dicitur cum intervallo suspensa. Et continua quidem est, qua loquentes vel prosam orationem legentes verba percurrimus . . . Διαστηματική autem est ea, quam canendo suspendimus, in qua non potius sermonibus sed modulis inservimus.*⁵³ Boethius also follows Aristoxenus in the human limitation put on the otherwise infinite extent of high and low pitch (I 13).

Although the passage undergoes some mutation in later treatments, Aristoxenus' discussion on the movement of the voice seems to be the original source for the elemental definition of music which appears in most subsequent treatises. Some theorists also adopt Aristoxenus' list of parts and his definitions of note, interval and *systema*, emphasising a progressive description of musical organisation. This dependence is due primarily to the fact that, before Aristoxenus, the need for an empirical presentation of the material of harmonic science had been overlooked. There had certainly been discussion about the nature of sound: the magnitudes of intervals are listed by Philolaus;⁵⁴ the relative speeds of high- and low-pitched sounds is presented by Archytas;⁵⁵ and sound as an impact on the air and the relative speeds of pitches is discussed by Plato.⁵⁶ In general, the Pythagoreans treat the acoustic issues of concords and ratios, sound and hearing. Aristotle also speaks of how concords are perceived, and in particular the problem of how the hearing can perceive two sounds simultaneously.⁵⁷ However, it is Aristoxenus who first attempts to define how a single note is understood by the perception in the context of melody. This initial definition forms the basis of all future investigation into musical sound.

We discussed previously how, in his revision of Book I of the *Harmonics*, Aristoxenus excludes this elemental discussion of musical sound. In Book II, the more refined version which divides harmonic science into seven parts assumes an understanding of the fundamental material of melodic sound. Accordingly, a delineation between musical sound and non-musical sound within this science is too preliminary for harmonics in the same way that a discussion of acoustics is superfluous. Harmonics, then, is concerned with the arrangement and order of sounds presumed to be capable of forming part of melody, the elements of which are notes. Yet for later theorists the focus on

melody to the exclusion of all else is not a criterion for harmonics, and they do not seek to limit the material of harmonic theory to the extent that Aristoxenus does, as is clear from the inclusion of various themes external to harmonics in their treatises. For Aristides Quintilianus, Ptolemy, Nicomachus and others without such rigid, self-imposed limitations, the movement of the voice and other acoustic ideas is not a subject outside the realm of harmonic science. It is not surprising that their treatises begin with distinctions between musical and non-musical sound.

4b. Notes

In many theorists the discussion of the vocal movement generally concludes with the definition of note as the basic element of musical sound and proceeds to the seven parts of harmonics. In Book I of the *Harmonics*, Aristoxenus also offers his definition of a note after his description of the movement of the voice: φωνῆς πτωσίς ἐπὶ μίαν τάσιν ὁ φθόγγος ἐστί.⁵⁸ As we discussed in Chapter Three, Aristoxenus' definition of harmonics establishes the material of the science concerned with melody. His definition of note creates the possibility of constructing a melody, as he explains that once a note appears to rest on a pitch it is able to be put into a melody.⁵⁹ In the second book, the theoretical emphasis is extended and Aristoxenus suggests that a note is not merely a pitch but a function, *dynamis* (36.6–12). Although the concept of *dynamis* is not introduced into the *Harmonics* until the second book, ideas preliminary to it (continuity and succession) are established in Book I.

The dynamic concept of a note which only has existence as part of a musically coherent system is absorbed into the consciousness of later theorists but not often explicitly discussed. Many theorists use a definition of note dependent on that of Aristoxenus, but this rarely leads into a methodological discussion on how his perception of a note differs from one which primarily assesses notes as one side of a numerical ratio. Indeed, Aristoxenus' contribution to the conceptual advance of musical methodology is often overlooked by his successors.

Cleonides' summary of the *Harmonics* clearly accepts Aristoxenus' description of harmonic space but barely includes the idea of *dynamis* or the methodology behind it. It therefore ignores much of Aristoxenus' achievements. After his initial account of the movement of the voice Cleonides refers to the dynamic nature of notes but offers no explanation of what this implies about the formation of musical structures: φθόγγοι δὲ εἰσι τῇ μὲν τάσει ἄπειροι, τῇ δὲ δυνάμει καθ' ἕκαστον γένος δεκαοκτώ.⁶⁰ Cleonides summarises in this sentence all of Aristoxenus' discussions on *dynamis*: the infinite variability of the moveable notes within a certain range; the potential

for a note to move in pitch but still be the 'same' note; and the possibility for the 'same' interval (such as a fifth) to occur in different positions in the scale. Rather than presenting the dynamic exposition of Aristoxenus, Cleonides then unnecessarily recites various lists of notes: notes according to each genus, notes of all the genera together, stationary notes, moveable notes, and notes according to position in the *pyknon* or tetrachord. On the other hand, Cleonides includes some description of *mese* as the central note of the greater perfect system with some emphasis on its dynamic position: ἀπὸ δὲ τῆς μέσης καὶ τῶν λοιπῶν φθόγγων αἱ δυνάμεις γνωρίζονται, τὸ γὰρ πῶς ἔχειν ἕκαστον αὐτῶν πρὸς τὴν μέσην φανερώς γίνεται.⁶¹ In general though, Cleonides ignores the methodology of Aristoxenus and merely reports his results.

By contrast, the definition of note employed by Aristides Quintilianus is not readily identifiable as Aristoxenian: φθόγγος μὲν οὖν ἐστὶ φωνῆς ἐμμελοῦς μέρος ἐλάχιστον.⁶² Like Cleonides, Aristides refers in a cursory way to some ideas about *dynamis* and succession, and has a corresponding lack of discussion about the dynamic nature of melody. His comments on notes suggest that he has misunderstood the significance of Aristoxenus' explanations about *dynamis* which, if he is particularly dependent on Cleonides' account, is not really surprising. Aristides produces a further statement which indicates his confusion about the function of notes: φθόγγων δὲ δυνάμεις ἄπειροι μὲν εἰσι τῇ φύσει, αἱ δὲ παραδεδομέναὶ συλλήβδην καθ' ἕκαστον τῶν γενῶν εἰκοσιοκτώ.⁶³ This might refer to the fact that the human construction of melody is arbitrary, and that there are other possibilities for the arrangement of musical sound. In the light of the general lack of examination of dynamic potential, however, and the cosmological-musical parallels presented in Book III of Aristides' treatise, I think that it is more likely that he has simply confused the issue, intending to say, as Cleonides does, that the pitches have a potentially infinite number of positions while the functions are limited.

An inadequate understanding, or perhaps an over-hasty abbreviation, also appears to be the problem in Aristides' discussion of intervals, where he reports some of Aristoxenus' theorems from Book III but not the principles or 'proofs' behind them: γίνεται δὲ ἡ σύνθεσις αὕτη τοιαύτη· δύο διέσεις ἐφεξῆς τίθενται, πλείους δὲ οὐκέτι· δύο ἡμιτόνια ἐφεξῆς τίθεται, πλείω δὲ οὐκέτι. δύο τόνοι τίθενται καθ' ἓνα, πλείους δ' οὐκέτι· περίστανται γὰρ τὸ ὅλον εἰς ἀσυμφωνίαν.⁶⁴ This recalls Aristoxenus' theorems from Book III, but he supplies no methodological support. Furthermore, Aristides does not acknowledge the possibilities of the diatonic genus (which of course can have three tones in succession) and therefore ignores the essence of the dynamic theory to account for the fact

that there can be variation of the interval sizes while the function of the notes is perceived to be the same.

In the later Aristoxenian theorists the need for some definition of the basic element of musical sound is almost universally accepted. Derivatives of Aristoxenus' definition of note are not uncommon, but certainly subject to other influences. While Gaudentius, for example, repeats Aristoxenus' definition from Book I almost exactly (329.7–11), Bacchius Geron's initial definition is more similar to that of Aristides Quintilianus. At the beginning of the treatise he defines a note (φθόγγος) as the smallest part of melody (ἐλάχιστον τῶν μελωδουμένων, 7).⁶⁵ Later he presents a more Aristoxenian definition as he attempts to establish the material of music and its primary element: τί πρῶτον στοιχείον τῶν κατὰ μουσικὴν;—φθόγγος· ὅ ἐστι φωνῆς τάσις ἐπὶ μίαν πτώσιν μέλους. πᾶς δὲ φθόγγος ἔχει σχῆμα ὄνομα δύναμιν.⁶⁶ Martianus Capella also acknowledges the nature of the note as the primary element of his subject but does not make a distinction between arithmetical and geometrical concepts, including both of them in his analogy: *ac prius de sonis, ubi artis est elementum. sonus quippe tanti apud nos loci est, quanti in geometricis signum, in arithmetice singulum.*⁶⁷

Like many Aristoxenians, some Pythagorean theorists adopt a progressive definition of musical elements. Although they do not often reproduce Aristoxenus' seven parts of harmonics, they do establish the basic structures of musical organisation, note, interval and *systema*. Thrasyllus, cited by Theon of Smyrna, attempts a division of the canon in his discussion of music⁶⁸ while his prefatory remarks include descriptions heavily dependent on the definitions contained in the second book of the *Harmonics*: διὰ τοῦτ' οὖν φθόγγος εἶναι λέγεται οὐ πᾶσα φωνὴ οὐδὲ πάσης φωνῆς τάσις, ἀλλ' ἡ ἐναρμόνιος, οἷον μέσης, νεάτης, ὑπάτης. διάστημα δὲ φησιν εἶναι φθόγγων τὴν πρὸς ἀλλήλους ποιὰν σχέσιν, οἷον διὰ τεσσάρων, διὰ πέντε, διὰ πασῶν, σύστημα δὲ διαστημάτων ποιὰν περιοχὴν, οἷον τετράχορδον, πεντάχορδον, ὀκτάχορδον. ἀρμονία δὲ ἐστὶ συστημάτων σύνταξις, οἷον Λύδιος, Φρύγιος, Δωρίου.⁶⁹ This in no way contradicts his mathematical ambitions, for it merely provides an empirical framework for his musical discussion. Moreover, the extent of Thrasyllus' exposition of this Aristoxenian perspective appears to be limited to these preliminary explanations.

On the other hand, Aristoxenus' ideas about continuity and succession appear to have more durability than his dynamic concept of notes. The work of Adrastus (circa first century CE) cited by Theon (49.6–72.20) demonstrates essentially a Pythagorean exposition of musical acoustics incorporating aspects of Aristoxenus' work. Without any acknowledgement of a non-

Pythagorean influence he refers to the way in which musical sound operates and the necessity of understanding musical elements as part of a pre-existing and orderly system: τὸ μέντοι ἐξῆς καὶ ἐμμελῶς ἐν τούτῳ προκόπτειν οὔτε ὥς ἔτυχε γίνεται οὔτε μὴν ἀπλῶς καὶ μοναχῶς, ἀλλὰ κατὰ τινὰς τρόπους ἀφωρισμένους, καθ' οὓς αἱ τῶν λεγομένων γενῶν τῆς μελωδίας θεωροῦνται διαφοραί.⁷⁰ This recalls the statement in Book I of the *Harmonics* concerning the orderly nature of harmonically attuned melody.⁷¹ Adrastus also adopts, without attribution, Aristoxenus' first axiom⁷² concerning the laws of continuity and succession which states that the fourth note in a sequence will make the interval of a fourth with the first note, or that the fifth note will make a fifth. His eagerness to extend the rule to include the fourth, fifth and octave does not take into account all the possibilities of the greater perfect system and the alternatives arising from the choice of conjunct or disjunct tetrachords. Despite his slight misinterpretation of the extent of Aristoxenus' Axiom I, this Pythagorean author has accepted into his understanding of music a sense of the natural and necessary arrangement of musical structures.

Nicomachus also repeats Aristoxenus' first axiom in his discussion of the division of the octave (Ch. 7). He separates the conjunct system from the disjunct, noting that the fourth note will be at a consonance of a fourth in the heptachord, while the fifth note will be at the consonance of a fifth in the octachord. Despite the use of the terms note, interval and *systema* throughout his treatise, Nicomachus only defines them in the final chapter, and the section appears to be an afterthought even though he claims it to be a reminder of what has already been mentioned (261.2–3). His definition of note is threefold, reflecting several influences: φθόγγος ἐστὶ φωνὴ ἄτομος, οἶον μονὰς κατ' ἀκοήν· ὥς δὲ οἱ νεώτεροι, ἐπίπτωσις φωνῆς ἐπὶ μίαν τάσιν καὶ ἀπλήν· ὥς δ' ἔνιοι, ἦχος ἀπλατῆς κατὰ τόπον ἀδιάστατος.⁷³ The first definition presents the note in terms of the Pythagorean monad, the second repeats Aristoxenus, while the third reflects a complaint in Aristoxenus about Lasus' conception of a note (3.20–23) and emphasises the parallel with the geometrical point.

Ptolemy's definition of note follows that of Aristoxenus: φθόγγος ἐστὶ ψόφος ἓνα καὶ τὸν αὐτὸν ἐπέχων τόνον.⁷⁴ Like Aristoxenus, Ptolemy has a sophisticated understanding of *dynamis*, but he uses the term in a way not seen in the remnants of Aristoxenus' writings. For both theorists, *dynamis* refers to the relationship of the notes to one another within a defined system. Yet for Aristoxenus this implies a flexibility about the pitch of moveable notes. Ptolemy, however, applies the term in the context of the modulation of *tonoi* and uses the term '*dynamis*' as distinct from '*thesis*' to describe the terminol-

ogy of the changeless and modulating systems (51.18 ff.). He distinguishes, for example, *mese kata dynamin* from *mese kata thesin*. The first refers to the position of the note as the lower note of the higher disjunctive tone (52.21), while the second refers to the note's absolute position in the centre of the two octave system. In the changeless system this refers to the same note, but when the system modulates, this ceases to be the case. It may be that Aristoxenus used the terms *dynamis* and *thesis* in such a way in his treatments of *tonoi* and modulation, but since his discussions have not survived it is difficult to establish whether he is the source of Ptolemy's description.

The opening of Boethius' definition of harmonics and its elements recalls Aristoxenus' exposition of the *Harmonics*: *sonus igitur est vocis casus emmeles, id est aptus melo, in unam intensionem*.⁷⁵ This definition of note is a translation of a definition attributed to "the Aristoxenians" by Porphyry: "φθόγγος ἐστὶ φωνῆς ἐμμελοῦς πτωσίς ἐπὶ μίαν τάσιν." ἢ "ἐμμελῆς οὖν φωνῆς πτωσίς ἐπὶ μίαν τάσιν."⁷⁶ Boethius' continuation of his definition confirms his dependence on Greek sources: *Sonum vero non generalem nunc volumus definire, sed eum, qui graece dicitur phthongos, dictus a similitudine loquendi, id est φθέγγεσθαι. Intervallum vero est soni acuti gravisque distantia. Consonantia est acuti soni gravisque mixtura suaviter uniformiterque auribus accidens*.⁷⁷ An ascending description of the elements of melodic structures seems to be imminent, but Boethius goes on to describe the role of reason and perception and Aristoxenus' programme of seven parts is not prescribed. As Nicomachus is the most likely source for this part of the treatise, this is not surprising.⁷⁸ What is more surprising is Boethius' emphasis on the genera in melodic analysis, which recalls Aristoxenus' placement of it as first of the parts of harmonics: *his igitur ita propositis, dicendum videtur, quot generibus omnis cantilena texatur, de quibus armonicae inventionis disciplina considerat*.⁷⁹

In sum, many theorists maintain the terminology of Aristoxenus' dynamic exposition of notes but rarely the methodological discussion which distinguishes his treatise. While *dynamis* is often mentioned by the Aristoxenians, its value and ramifications remain unacknowledged and unexplored. Consequently, this aspect of Aristoxenian theory often becomes reduced to lists of notes. The treatises of Cleonides and Aristides Quintilianus, in particular, exemplify the failure of Aristoxenus' attempt to create in harmonics an axiomatic and absolute exposition of an arbitrarily organised science subject to human convention.

4c. Intervals

One essential difference between the Aristoxenian and Pythagorean harmonic sciences centres around their methods for describing intervals, either with an

empirical assessment in terms of tones, or as a numerical ratio. The problem generated considerable polemical debate in early analyses of musical structures, not the least from Aristoxenus. Yet in the following centuries these opposing techniques of interval representation were included in some works with a minimum of methodological discussion.

The consonant intervals of low-integer epimoric and multiple ratios are naturally the least problematic for Pythagorean theorists. They are easy to calculate and give no cause for conflict with the Aristoxenians, for both accept that the fourth is the smallest consonance, that the octave consists of a fourth plus a fifth, and that the difference between a fourth and a fifth is a tone. It is the measurement of the semitone which produces the first hurdle for Pythagorean theorists. While the Aristoxenians could happily assert that the size of the interval is 'half a tone,' and the size of the fourth is 'two and a half tones,' the Pythagoreans were presented with considerable problems. Not only did the mathematicians insist that epimoric intervals could not be halved rationally, the remainder of the fourth minus two tones was clearly not a semitone and, at 256:243, not a particularly tidy-looking ratio. Many of them, however, were content to incorporate this interval, with its anomalous ratio, into their systems, relying, perhaps, on the authority of Plato's *Timaeus* (36a-b).

Despite this some treatises combine different techniques of interval analysis with no methodological comment at all. Several Aristoxenians including Martianus Capella, Cassiodorus and Aristides Quintilianus, present the simple ratios for the concords and the tone despite the fact that they have no ambition to provide mathematical analyses of the tetrachord.⁸⁰ Cleonides and Bacchius Geron, however, are the exceptions to this general rule. Cleonides distinguishes rational and irrational intervals in his comments on intervals, but his definition has no reference to numerical ratios: ῥητὰ μὲν οὖν ἐστὶν, ὧν οἶόν τε ἐστὶ τὰ μεγέθη ἀποδιδόναι, οἶον τόνον ἡμιτόνιον δίτονον τρίτονον καὶ τὰ ὅμοια· ἄλογα δὲ τὰ παραλλάντοντα ταῦτα τὰ μεγέθη ἐπὶ τὸ μείζον ἢ ἐπὶ τὸ ἔλαττον ἀλόγῳ τινὶ μεγέθει.⁸¹ The source of this definition is problematic since, although Aristoxenus anticipates discussing the distinction of rational (ῥητὰ) and irrational (ἄλογα) intervals (16.30), he never returns to the subject in the *Harmonics*. However, in the *Rhythmics* he defines rational and irrational rhythms and explains: ὥσπερ οὖν ἐν τοῖς διαστηματικοῖς στοιχείοις τὸ μὲν κατὰ μέλος ῥητὸν ἐλήφθη, ὃ πρῶτον μὲν ἐστὶ μελωδούμενον, ἔπειτα γνώριμον κατὰ μέγεθος, ἥτοι ὡς τὰ τε σύμφωνα καὶ ὁ τόνος ἢ ὡς τὰ τοῦτοις σύμμετρα.⁸²

Conversely, Aristides Quintilianus notes in his discussion of intervals a non-Aristoxenian distinction between rational and irrational intervals: ῥητὰ

μὲν ὦν καὶ λόγον ἔστιν εἰπεῖν ποιόν (λόγον δέ φημι τὴν πρὸς ἄλληλα κατ' ἀριθμὸν σχέσιν), ἄλογα δὲ ὦν οὐδεὶς πρὸς ἄλληλα λόγος εὐρίσκεται. τοῦ μὲν οὖν διὰ τεσσάρων λόγος ἔστιν ἐπίτριτος, τοῦ δὲ διὰ πέντε ἡμιόλιος, τοῦ δὲ διὰ πασῶν ὁ διπλασίων, τόνου δὲ ὁ ἐπόγδοος.⁸³ While Aristides has adopted the need to distinguish rational and irrational intervals from the *Harmonics*, he appears to have adopted the definition of the distinction from the Pythagorean tradition. Despite further recital of ratios in Book III, including that of the *diesis*, and a description of the canon, Aristides does not attempt a complete set of divisions of the tetrachord according to numerical ratios.

In Chapter 7 of his third book, however, Aristides tries to explain away an apparent inconsistency in his approach: τάχ' οὖν ἂν τις ὑπολάβοι μὴ συνεστάναι τὸν λόγον ἡμῖν τὴν μὲν ἐξέτασιν τῶν κατὰ μουσικὴν ἐπ' ἀριθμῶν ποιουμένοις, αὐτῶν δὲ τούτων φάσκουσι καὶ μὴ τελείως εἶναι δεκτικὰ τὰ διαστήματα.⁸⁴ Aristides does not attempt a methodological explanation for the numerically asymmetrical arrangement of musical space but instead resorts to one dependent on natural philosophy. An analogy is drawn between the way in which a ray of the sun is seen clearly in the air but becomes murky under the surface of the ocean, and the way in which music is tainted as it descends from the heavens to the sublunary sphere: μουσικὴν δὲ καὶ αὐτὴν ἀρχὴν μὲν ἔχειν ἐκ τῶν ὅλων, ὥσπερ καὶ τὰ ἄλλα, εἰπεῖν οὐκ ἀπίθανον, τῇ δὲ πρὸς τὴν σωματικὴν ὕλην μίξει τῆς κατὰ τοὺς ἀριθμοὺς ἀποπίπτειν ἀκριβείας τε καὶ ἀκρότητας, ἐπεὶ ἐν γε τοῖς ὑπὲρ ἡμᾶς τόποις ἀτρεκὴς τέ ἐστι καὶ ἀδιάφθορος. οὕτως καὶ τὰς εἰς ἴσα τῶν διαστημάτων διαιρέσεις ἀδυνατοῦμεν καὶ τὰς τῶν συστημάτων συμφωνίας ἐλλιπεῖς ἔχομεν τῆς σωματικῆς παχύτητος παρεμποδίζουσας.⁸⁵

The theorists using primarily Pythagorean methods were similarly aware of the inaccuracy of Aristoxenus' description but were variously capable of explaining the arithmetic necessary to prove it. In his discussion on the size of intervals, Adrastus specifically states that Aristoxenus is mistaken in considering the semitone to be half a tone and appears to refer to Proposition 3 of the *Sectio Canonis* concerning epimoric intervals: δείκνυται γὰρ ὁ τόνος μηδ' ὅλως εἰς δύο ἴσα διαιρεῖσθαι δυνάμενος, ἐν λόγῳ θεωρούμενος ἐπογδόω, καθάπερ οὐδ' ἄλλο τι ἐπιμόριον διάστημα. τὰ γὰρ θ' οὐχ οἷόν τε διαιρεθῆναι εἰς ἴσα.⁸⁶ The final sentence indicates that the author has misunderstood the logic behind the impossibility of dividing epimoric intervals, but he accepts the assertion that a tone cannot be divided equally.⁸⁷ This does not prevent him from describing the generic

divisions of the tetrachord in Aristoxenian terms, including the use of the term “semitone” without further qualification.

Nicomachus is also inconsistent with his use of the term semitone. In Chapter 7 of his treatise he offers a calculation of the diatonic genus through whole tones (9:8), but does not state precisely the interval of 256:243, referring to it as the “so-called” (λεγόμενος) semitone (249.10). When, in Chapter 12, he describes each of the genera using the empirical terminology of Aristoxenus, he makes it clear that the interval he has been calling a semitone is not in fact exactly half a tone and refers to Philolaus’ description of the octave as five epogdoics and two *dieses* (264.2–5). Despite his several chapters on the historical discovery and application of the ratios of consonances, Nicomachus’ mathematical expression of musical structures is limited. The theoretical side of his discussion remains unsupported by complete tetrachordal divisions (though in Chapter 11 he promises that these will be given in a later and more elaborate work) and while he edges towards some mathematical calculations he only reproduces the tetractys of 12:9:8:6.

On the other hand, Ptolemy presents a detailed discussion on the definition of intervals including some methodological assessment of earlier interval analysis. He criticises the Pythagorean judgement of consonant intervals and claims that they are too dependent on reason to the exclusion of perception for, having accepted the nature of consonance to be limited to those intervals represented by an epimoric or multiple ratio and consisting only of the numbers one to four, they discount the clearly consonant eleventh (an octave plus a fourth) because of its ratio of 8:3.⁸⁸ Ptolemy rejects such a sharp distinction between consonant and dissonant intervals, suggesting a gradation of consonance which can accept the eleventh as the product of an octave plus a consonant interval. On the other hand, he criticises Aristoxenus’ circular assessment of intervals which are measured by parts of themselves. Although strictly accurate, Ptolemy’s criticism misses the real point about Aristoxenian methodology, and fails to take into account its ambition to establish an empirical terminology for harmonic science.

Boethius, depending heavily on Ptolemy’s analysis of Pythagorean and Aristoxenian methods of harmonic investigation, expresses the methodological difference between the two schools: *Aristoxenus quippe sonorum differentias secundum gravitatem atque acumen arbitrabatur in qualitate consistere, Pythagorici vero in quantitate ponebant.*⁸⁹ This is a simplified analysis of Aristoxenus’ approach upon which Boethius does not expand. His terminology has probably been influenced by the symmetry of the opposing nouns quality and quantity. The ‘qualitative’ analysis attributed to Aristoxenus actually suggests an understanding of pitch akin to that of

Theophrastus noted above. But there is some truth in Boethius' proposal, since the quality of a note can represent its function within a system. Although Boethius sets up this opposition between Aristoxenus and the Pythagoreans, he does not take the opportunity to develop a methodological debate. Most of the treatise is taken up with arithmetical calculation, and Aristoxenus is most often mentioned simply in order that his interval calculations be discredited.

In general, many later musical works avoid or obscure references to the specific nature of the contradiction between Aristoxenians and Pythagoreans and although they often include elements of both theories this is often done without any methodological explanation. Several authors are happy to describe intervals with the empirical terms used by Aristoxenus, such as semi-tone, while admitting that such appellations are inaccurate. A general exception to this cursory treatment is to be found in the work of Ptolemy, who actually attempts to address the problem in detail. Like Aristoxenus Ptolemy challenges earlier attempts to present the science of harmonics and tries to correct the mistakes made by his predecessors.

4d. *Genera*

In the *Harmonics* Aristoxenus spends considerable time discussing the nature of the genera, and its importance to him is emphasised by the fact that it is placed first among the seven parts of harmonic science. Six shades of tetrachordal division are described (one enharmonic, three chromatic and two diatonic). He emphasises that these tunings are not absolute, merely the most familiar examples (50.21–4), and that the position of moveable notes in each genus is infinitely variable within a certain range (46.23–47.8). Such flexibility about pitch range is not transmitted into the works of later theorists who tend to reproduce either the standard six nuances, or one tuning for each genus, without methodological explanation. Similarly, tetrachordal division according to the three genera is one of the principal subjects of Pythagorean theory. Naturally, the lack of flexibility about precise tunings in later Aristoxenian theorists was already present in the methodology of the Pythagoreans.

The presentation of the genera by the Aristoxenians is fairly uniform. Aristoxenus' three genera with six total divisions are enumerated by Cleonides (Chs. 6–7) and Aristides Quintilianus (15.21 ff.), while Bacchius Geron (21–24) and Martianus Capella (IX 957) report one division for each genus, the latter noting *sed nunc maxime diatono utimur*.⁹⁰ A reduction in the use of the non-diatonic genera by practising musicians⁹¹ may account for the fact that, of later theorists, neither Isidore of Seville nor Cassiodorus men-

tion genus at all, though that may equally be owing to the brevity of their treatments.

Unexpectedly in the middle of Gaudentius' treatise (Chapters 10–16, 339.21–344.24), there is an extended Pythagorean treatment of genera. We find not just a brief overview of the ratios of consonant intervals (as we have seen in Cassiodorus and Martianus Capella) but the initial steps of a complete calculation for the division of the canon for the diatonic and chromatic genera over a double octave system. His tetrachords correspond generally to those of Philolaus, including a ditonal diatonic and a chromatic divided into an interval of 32:27 and a *pyknon* of a tone which is further divided into *diesis* and *apotome* (256:243 + 2187:2048). Despite the fact that this extended Pythagorean section comes amidst an Aristoxenian exposition in which Aristoxenus' divisions are given for the three genera, there is still no comment on the different terminology of the schools. Gaudentius notes in his discussion of the genera that, besides the diatonic, τῶν δὲ λοιπῶν δυοῖν ἡ χρῆσις ἐκλελοιπέναι κινδυνεύει.⁹² This statement might conceivably explain the exclusion of calculations for the enharmonic (even though it appears in a different part of the treatise, in a wholly Aristoxenian context), but it casts doubt on Gaudentius' reasons for including the calculations for the chromatic.⁹³ As his account of musical theory is firmly in the Aristoxenian tradition it is difficult to decide whether he refers to a lapse in the fourth century BCE or his own, for Aristoxenus had already noted the decreasing popularity of the enharmonic, but not of the chromatic.

A common feature of tetrachordal division in many theorists is an interdependence between genera.⁹⁴ In Aristoxenus this is most obvious since the lowest interval of the commonest forms of the diatonic and chromatic equals the *pyknon* of the enharmonic. The chromatic *pyknon* is then double the enharmonic *pyknon*. While in Aristoxenus this is a fairly simple operation, we also find it in the Pythagorean tradition whose treatments seem to develop along two lines.

These lines of progress may be differentiated according to the level of arithmetic employed—and understood—and the extent of its exploitation for musical purposes. Some theorists indulge in a little acoustic examination and attribute numerical ratios to intervals but rarely extend this approach to attempt complete calculations for all three genera. This group tends to highlight the inaccuracy of the appellation of the semitone (because of the impossibility of dividing epimoric intervals equally) yet relies on Aristoxenus' empirical descriptions for its summary accounts of the genera.

The divisions of tetrachord for these Pythagoreans does not evolve far beyond the level of Ps.-Euclid, which means that, although the diatonic is

described as containing two 9:8 tones and a *diesis*, often the calculation for the interval of the *diesis* is not stated. Similarly the enharmonic division related to this 'Pythagorean diatonic' simply consists of a ditone (81:64) and the remaining *pyknon*. The chromatic, if it rates a mention, is based on that of Philolaus and consists of a *pyknon* of a tone, and an upper interval of 32:27. While sometimes the full calculations for each interval can be deduced, the theorist does not state precisely the ratios involved. Indeed, at times there appears to be little difference between these Pythagoreans and many Aristoxenians, who also indulge in some rational description before presenting Aristoxenus' divisions. Yet the emphasis on acoustic theory and the need to comment on the imprecision of the semitone, regardless of whether it is given an exact ratio, along with the ambition to express cosmological or human parallels to musical structures, sets them apart from the Aristoxenian tradition.

We find examples of this less sophisticated arithmetic division in the works of Thrasyllus and Nicomachus. Thrasyllus' attempt at canonic division is similar to the final propositions of the *Sectio Canonis*, and his tetrachordal calculations include the Pythagorean diatonic and its associated enharmonic with an undefined *pyknon* division.⁹⁵ He carries over this interval of 256:243 into his chromatic genus which has a *pyknon* of a tone and an upper interval of 32:27. The middle interval can be calculated at 2187:2048 although this is never stated precisely by Thrasyllus nor is its difference from the *diesis* noted.

It is somewhat surprising that the calculations in Nicomachus' *Enchiridion* also belong to this tradition of under-exploited mathematics, considering that Nicomachus wrote a treatise on arithmetic. However, as we noted above, he composed his harmonics manual in transit, without the advantage of having the material from which he cites before him. It is possible, of course, that Nicomachus does not estimate the intellect of his pupil very highly, and is trying to keep his treatise simple, but in any case he only offers the calculation for the two epogdoic tones of the diatonic tetrachord, without specifying the ratio of the "semitone." He notes the derivation of the chromatic and enharmonic genera from the ditone diatonic (Ch. 7, 249.1 ff.), promising to explain it in more detail later. In the final chapter, he sets out the three genera in Aristoxenian terms (262.11 ff.).

The second stream of Pythagorean theory has a markedly greater emphasis on the arithmetical process and so tetrachordal divisions become more elaborate, even though many theorists still refer to Aristoxenus' divisions. It appears that the higher standard of arithmetical skill allowed these authors to indulge the ambition to represent the practice of musicians as well as mathematical balance. Archytas, in the first half of the fourth century BCE, pro-

vided divisions of the tetrachord in which, even though not all of his intervals are represented by epimoric ratios, each interval can be found through epimoric calculations, as Barker has shown.⁹⁶ Through their similarity to Aristoxenus' divisions, Archytas' tetrachords can be seen to reflect something approximating performance practice,⁹⁷ and his calculations formed the basis of this style of Pythagorean tetrachordal analysis.

The writers tending towards these more sophisticated calculations include Eratosthenes (third century BCE) and Didymus (first century CE) both of whose tetrachordal divisions Ptolemy cites in his *Harmonics*. Eratosthenes' divisions of all three genera show the influences of Aristoxenus' description of the tetrachord, in that, although he attempts to maintain epimoric ratios for intervals, he also appears to be trying to represent the intervals of Aristoxenus' division. In his enharmonic, the larger interval (19:15) is as close as possible to the pure ditone rather than the epimoric major third (5:4).⁹⁸ Because the upper interval of the tetrachord almost equates a ditone, the remaining *pyknon* of 20:19 is also close to the *diesis* of the Pythagorean diatonic accepted by Eratosthenes.

By contrast, Didymus' tetrachordal division grants priority to epimoric intervals and therefore rejects the Pythagorean diatonic, thereby demonstrating a concern with neat arithmetic over the practical representation of the ditone which we see in Eratosthenes' divisions. His upper enharmonic interval of 5:4 is the same as that used by Archytas.⁹⁹ Didymus manages to create an interdependent system, with the *pyknon* of the enharmonic equal to the lowest interval of the chromatic and diatonic genera.

Despite these subtle variations in mathematical representation, the actual intervals represented by the Pythagorean tetrachordal divisions were almost indistinguishable perceptibly. Many, such as those of Archytas and Eratosthenes, are in fact very close to the divisions of Aristoxenus. This may indicate a stable tuning tradition over a long period, but it may also indicate merely a static theory about tuning.¹⁰⁰ There is, for example, evidence that performance practice was changing during this period, even in the fourth century; Aristoxenus gives us an indication of the enharmonic genus falling into disuse, when he compares the ditone *lichanos* of the first and second groups of "ancient styles" (τῶν ἀρχαϊκῶν τρόπων 23.9–10) to the sweeter interval in use in the "style of composition presently in vogue" (τῇ νῦν κατεχούσῃ μελοποιίᾳ 23.12). He further complains of performers μάλιστα μὲν γὰρ καὶ πλείστον χρόνον ἐν τῷ χρώματι διατρίβουσιν, ὅταν δ' ἀφίκωνταιί ποτε εἰς τὴν ἁρμονίαν, ἐγγὺς τοῦ χρώματος προσάγουσι συνεπισπωμένου τοῦ μέλους.¹⁰¹ Therefore, the 5:4 interval used in the enharmonic by both Archytas and Didymus may indicate a performance practice as well as a concern for mathematical symmetry.

Ptolemy's presentation of the division of the tetrachord produces a surprising mixture of mathematical manipulation as well as a concern for practical representation.¹⁰² While the process by which he produces his divisions is systematic and theoretical, he also makes a point of separating out the genera "familiar" to the hearing (Book II, Chapter 15, 74.4 ff.) and providing canonic divisions for these tunings in each of the seven *tonoi*. These divisions are all diatonic and chromatic, and the following chapter (Book II, Chapter 16, 80.6 ff.) concerns the use of these familiar tunings in lyre and kithara music, demonstrating clearly Ptolemy's unwillingness to abstract his thesis entirely from the real world of musical performance.

Despite this clear association with the music of current practice, Ptolemy's divisions include extensive abstract arithmetical reasoning and methodological discussion. He not only justifies his own approach but criticises the attempts of his predecessors, including Aristoxenus and Archytas. He complains that not all the ratios employed by Archytas are epimoric, that the ratio of the lowest interval is the same (28:27) in each genus and that Archytas only calculates one division for each genus (32.1–18). However, although Ptolemy heavily criticises Archytas' achievements and the too-theoretical (θεωρητικώτερον 5.26) approach of the Pythagoreans, he does essentially adopt the Pythagorean method.

On the other hand, the influence of Aristoxenus is apparent in spite of the never complimentary references to him and his followers. Despite his willingness to indulge in methodological analysis, Ptolemy pays no attention to the dynamic nature of Aristoxenus' theory. Some of his negative judgements are nonetheless justified: he complains, for example, that the *dieses* of the soft and hemiolic chromatic differ by an imperceptibly small interval, only a twenty-fourth tone (32.19–20). Less justified is Ptolemy's denial of the ability of the perception to accept Aristoxenus' divisions and his disapproval of Aristoxenus' equal division of the *pyknon* (32.24–29). Furthermore, in his citation, Ptolemy misrepresents Aristoxenus' divisions and (as he divides a fourth into 30 units, but then treats the division as representing lengths on a single string, not as abstract interval sizes) distorts the calculations for the octave (69.30 ff.).

Ptolemy also criticises Aristoxenus for having not enough diatonic and too many chromatic divisions (32.19–20), but the complaint about the diatonic divisions might be unwarranted. It is quite possible that by the second century the diatonic was much more widely used and therefore subject to a greater variety of tuning practices. Already in Aristoxenus' time the enharmonic was falling into disuse and it is evidenced by the remains of musical texts in the papyri that by the time of the later treatise the diatonic was even

more popular.¹⁰³ Indeed, four out of the five tetrachords of Ptolemy's familiar genera are diatonic.

The inclusion in Ptolemy's *Harmonics* of Aristoxenian and Pythagorean techniques of analysis acknowledges the equal legitimacy of their contributions even though the author is critical of the results. However, despite the fact that he uses several aspects of Aristoxenus' work, Ptolemy never admits that he has done so. He adopts for his own calculations the mathematical expressions of the Pythagorean school, taking their techniques of numerical analysis to a more sophisticated level. He attempts to calculate as many epimoric divisions as his chosen mathematical procedure will generate and in fact the only genus division which he includes that is not entirely composed of epimoric intervals is that of the traditional Pythagorean diatonic.

Ptolemy's most extreme example of his theoretical emphasis on epimoric division is his even diatonic. This shade divides the fourth into almost equal parts 12:11 11:10 10:9 (38.13–39.6). It does not reflect the empirical description of any division and Ptolemy seems to claim that he has composed this artificial division himself. It is the only diatonic not to be included among his "familiar" genera.¹⁰⁴

On the other hand, Boethius does not indulge in this sophisticated arithmetical manipulation in tetrachordal division. This is only to be expected, as his section treating the genera occurs in the part of the treatise dependent on Nicomachus. Accordingly, his first description of the three genera (I 21) uses empirical terminology and his later tetrachordal divisions follow a traditional Pythagorean path. Unlike Ptolemy's extensive and abstract calculations, the divisions which Boethius presents create an interdependent system of three genera.¹⁰⁵ The enharmonic and the diatonic follow the Pythagorean division of two tones and a *diesis*. Unlike the exposition from Nicomachus' *Enchiridion*—but who knows what Nicomachus created in his later work?—the enharmonic *pyknon* is divided into intervals of 499:486 and 512:499 by using an arithmetic mean. The chromatic also makes use of the arithmetic mean to position the *lichanos* at approximately a tone and a half from the *mese*.¹⁰⁶ In this way it does not quite conform to the more common Pythagorean chromatic division of a tonal *pyknon* and upper interval of 32:27. However, the lowest interval of the chromatic is the same as that of the diatonic and as the enharmonic *pyknon*. In the fifth book (V 16), for which the source is Ptolemy, there is a further discussion of genera which reproduces all six of Aristoxenus' tetrachordal nuances and cites Ptolemy's criticism, thus ensuring its transmission into the Middle Ages. If Boethius had finished his treatise, it is possible that he would also have reproduced Ptolemy's arithmetically complex group of tetrachords.

As our discussion of genera has shown, the framework of Greek musical theory remains focused on the definition for three genera despite a probable decline in practical music of all but the diatonic. In a period extending from Archytas to Boethius—in which Aristoxenus is no exception despite using a different method for expressing intervals—this remains a principal concern of Greek musical theory. Aristoxenus' contribution was to introduce into the mathematically oriented discussion a language to describe the genera as they appeared to the perception. This language complemented rather than overturned Pythagorean ratio calculation and the two systems often appear together in the later works.

4e. *Systemata and Tonoι*

The problem with comparing the development of Aristoxenus' theory in the remaining areas of harmonic science is that his treatments of these subjects have not survived completely or directly. Instead, his exposition about *systemata* and *tonoi* must be pieced together from clues in the *Harmonics* and from Cleonides' summary work. From these we can presume that a systematic enumeration of scale systems was one of the principal features of the lost sections of the *Harmonics*. It is likely that this included an enumeration of the species (εἶδος) of the fourth, fifth and octave and a description of the greater and lesser perfect systems.

Aristoxenus criticises earlier theorists for their lack of systematic examination and he promises in Book I that his own discussion of *systemata* will be exhaustive: ἀποδειχθέντων γὰρ τῶν ἀσυνθέτων διαστημάτων ὃν τρόπον πρὸς ἄλληλα συντίθεται περὶ τῶν συστάντων ἐξ αὐτῶν συστημάτων λεκτέον περὶ τε τῶν ἄλλων καὶ τοῦ τελείου, ἐξ ἐκείνων ἀποδεικνύοντας πόσα τ' ἐστὶ καὶ ποῖ' ἅττα, τὰς τε κατὰ μέγεθος αὐτῶν ἀποδιδόντας διαφορὰς καὶ τῶν μεγεθῶν ἐκάστου τὰς τε <κατὰ σχῆμα καὶ> κατὰ σύνθεσιν <καὶ κατὰ θέσιν> ὅπως μηδὲν τῶν μελωδουμένων μήτε μέγεθος μήτε σχῆμα μήτε σύνθεσις μήτε θέσις ἀναπόδεικτος ᾗ.¹⁰⁷ This ambition for systematic description of musical forms is adopted by many later theorists.

Aristoxenus complains in the *Harmonics* about the chaotic state of contemporary theories about the *tonoi* and compares them to the different calendars followed by various cities in Greece (37.13–38.3). If the evidence of Cleonides is to be believed (203.4–204.9), Aristoxenus describes two sets of octave *systemata*: the first consists of seven octave species, given geographical names attributed to the “ancients,” while the second is a set of thirteen *tonoi*, whose *mesai* are separated from one another by a semitone and cover an octave. This second group is also given geographical names, with the extra

names being made up by designations of 'higher' and 'lower' for five of the species, and the addition of the Hypermixolydian. The organisation of the later system, in which each *tonos* is a semitone from the *tonos* next to it, and in which hyper- scales are a fourth above their original, hypo- scales a fourth below, is highly artificial. In addition, many of these scales are given secondary names, in an apparent attempt to reconcile several traditions, possibly the conventions of an older theory or the terminology of practising musicians. Aristides Quintilianus, probably using Cleonides as a source, also recites this set of thirteen *tonoi* and attributes them to Aristoxenus (20.1 ff.). They are listed below:

<i>Octave Species</i>	<i>Tonoi</i>
(Hypermixolydian)	Hypermixolydian (Hyperphrygian)
	Higher Mixolydian (Hyperastian)
Mixolydian	Lower Mixolydian (Hyperdorian)
Lydian	Higher Lydian
	Lower Lydian (Aeolian)
Phrygian	Higher Phrygian
	Lower Phrygian (Iastian)
Dorian	Dorian
Hypolydian	Higher Hypolydian
	Lower Hypolydian (Hypoaeolian)
Hypophrygian	Higher Hypophrygian
	Lower Hypophrygian (Hypoastian)
Hypodorian	Hypodorian

Despite Aristoxenus' attempt to establish a standard system, consensus never seems to have been reached. While many theorists followed the idea of a complete enumeration of scale systems, they clearly did not agree on how the arrangement of the *tonoi* was to be realised. Nonetheless, the group of seven octave species which seem to reflect an older tradition of ethnic *harmoniai* are more commonly described by later theorists than the larger group of thirteen.¹⁰⁸

Aristides Quintilianus refers to the seven octave species only implicitly, and in connection with the older tradition of *harmoniai*, but at the end of his chapter on genus (18.5 ff.) he also describes an irregular set of six scales which he claims to be the *systemata* referred to by Plato in the *Republic*. The scales include the Lydian, Dorian, Phrygian, Iastian, Mixolydian and tense Lydian.¹⁰⁹ Aristides remarks on the irregularity of the scales in the collection: ἐνίοτε μὲν οὖν αὐταὶ τέλειον ὀκτάχορδον

ἐπλήρουν, ἔσθ' ὅπη δὲ καὶ μείζον ἑξατόνου σύστημα, πολλάκις δὲ καὶ ἔλαττον· οὐδὲ γὰρ πάντας παρελάβανον αἰ τοὺς φθόγγους.¹¹⁰ The discussion of these scales adds a conscious historical dimension to the treatise suggesting a pre-systematised version of the octave species. The problem of the historical accuracy of theoretical accounts is highlighted by this passage as there is no way of verifying Aristides' account and no way of knowing if these are the scales referred to by Plato. If these scales were in use at the time of Plato, is it possible that they were still in use when Aristoxenus was writing his treatise? Can we then assume that Aristoxenus was responsible for the systematisation of the greater perfect system? This putative systematisation may reflect a change in contemporary performance practice or merely be a theoretical device. Unfortunately, the evidence on this matter is inconclusive and the answers are beyond us.

Other theorists present a less controversial arrangement of scales, often within the context of a larger scale system. Cleonides, for example, marks out the species of fourth and fifth by the notes of the greater perfect system. Similarly, Nicomachus refers to the species of the fourth and fifth (Ch. 7, 249.15 ff.) explaining that the heptachordal system held the species of the fourth, while the octachord held the species of the fifth. Conversely, Aristoxenus (initially at least) had described each species of the fourth independently from other structures: *πρῶτον μὲν οὖν οὗ τὸ πυκνὸν ἐπὶ τὸ βαρύ, δεύτερον δ' οὗ δίεσις ἐφ' ἑκάτερα τοῦ διτόνου κείται, τρίτον δ' οὗ τὸ πυκνὸν ἐπὶ τὸ ὀξύ τοῦ διτόνου.*¹¹¹ However, as his treatment of the species of the fourth is the point where the *Harmonics* breaks off, it is impossible to tell whether Aristoxenus maintained this independent description of structures, or placed them into a position in the greater perfect system.

In the works of some Aristoxenians, the representations of the seven species of the octave present some continuity. Gaudentius enumerates the species of the fourth, fifth and octave (Ch. 18 and 19, 345.13–347.10) in the context of the greater perfect system. He notes that there are twelve possible species of the octave, but only seven are melodic and consonant (*ἑμμελῆ καὶ σύμφωνα*, 346.10). To these he attributes the seven geographical names which Cleonides has attached to the octave species and associated with the ancients. Bacchius Geron also enumerates the fourth, fifth and octave (75–77, 308.8–309.12) and attributes to the octave species the same geographical appellations. Aristides, even though he does not specifically enumerate species, does note that systems have a variety of arrangements (14.33–15.2).

Later Aristoxenians posit alternative and more contrived systems which add two superfluous *tonoi* to Aristoxenus' set of thirteen.¹¹² This incorporates a group of five central scales flanked on either side by a group of hyper-species

above and hypo-species below. Cassiodorus, Alypius and Martianus Capella all describe systems of fifteen *tonoi*.¹¹³ Cassiodorus' central group of scales incorporates Lydian, Aeolian, Phrygian, Iastian, and Dorian, which maintains the interval of a tone between Lydian and Phrygian, Phrygian and Dorian existing in the original set of octave species. In addition, the names reported by Cassiodorus fit into Aristoxenus' system of *tonoi*, using some of the alternative names noted by Cleonides. Similarly, Alypius' central set in his group of fifteen *tonoi* has only a minor change from the "original" set, replacing Iastian with Ionian. However, the origin of the arrangement of Martianus Capella is less clear. His central set includes Lydian, Ionian, Aeolian, Phrygian and Dorian, whose arrangement allows only a semitone between the Phrygian and Dorian *tonoi*, but a trisemitone between the Lydian and Phrygian.

On the other hand, the system of thirteen *tonoi* is rejected by Ptolemy and Boethius. Ptolemy specifically states that the *tonoi* should not be separated by semitones (64.16 ff.) and that there are only seven, corresponding to the seven species of the octave. The ethnic appellations employed in Ptolemy's description conform to the arrangement of Cleonides' seven species (62.16–64.15). Included in his systematic account are the species of fourth, fifth and octave (49.4 ff.) and the complete *systema* of a double octave. Like his source Ptolemy, Boethius describes musical structures in the context of a detailed account of modal theory (IV 14–17) and accepts Ptolemy's arrangement of seven modes, mirroring the seven octave species. Contrary to his source, Boethius accepts the possibility of an eighth mode, the Hypermixolydian, despite the fact that this duplicates the interval arrangement of the Hypodorian.

Therefore, while some level of continuity can be seen in the several arrangements of the *tonoi* within the greater perfect system, there is no clear consensus. Aristoxenus (or Cleonides) may have been attempting to reconcile some different traditions in his inclusion of two names for many of the *tonoi* but did not succeed in establishing a definitive system. The tonal series which appears to be the most resilient is not Aristoxenus' rather artificial arrangement of thirteen *tonoi*, but the set of seven *tonoi* which conform to the seven octave species.

CONCLUSION

Aristoxenus' harmonic treatise was influential in two principal ways. Firstly, his identification of the musical element was essential to establish a language for the empirical discussion of music. Secondly, his systematic enumeration of musical structures set the programme for many later treatises. These two facets of his work were adopted by many later authors, both in the Pythagorean tradition as well as that claiming to follow Aristoxenus himself.

Yet, even though Aristoxenus' *Harmonics* significantly influenced the development of musicology, there is little explicit acknowledgement of his contribution in the work of later theorists. There is in fact a consistent lack of theoretical understanding about the nature of Aristoxenus' theory, and about the way in which numerical and dynamic explanations of musical structures could complement as well as contradict one another.

The lack of methodological discussion in later theorists contributed to the declining standard of representation of Aristoxenian harmonic theory. Instead of placing moveable notes within a range of pitches, comprehensible by their position within a system, many theorists simply reproduced the standard measurements for tetrachordal divisions and reduced Aristoxenus' systems to lists of notes. Consequently, Aristoxenus is often the victim of criticism for his approximate measurement of intervals while the dynamic nature of his analysis remains unappreciated or even ignored. Even Ptolemy and Boethius, who do consider the methodological implications of their work, complain that Aristoxenus' tetrachordal measurements are based on perception and can be proved false by reason.

At the same time, almost all later musicologists adopted in some form Aristoxenus' distinction between continuous and intervallic movement as the criterion for establishing melodic sound. This is an essential insight about the way in which music is perceived and it establishes that an element, the note, must be isolated before the discussion of musical sound can begin. Therefore it is not surprising that many theorists also adopt Aristoxenus' definition of note, interval, and *systema* in order to employ his fundamental understanding of musical structure.

The Aristoxenian depiction of musical elements could be added to the Pythagorean concern for mathematical relationships without undermining its validity. Indeed, the most sophisticated treatises from the ancient world happily adopt techniques from both the empirical and mathematical traditions. While the precise calculations of the Pythagorean school disprove Aristoxenus' approximations, his empirical descriptions of musical elements and the systematic exposition of musical structures contribute to broaden a purely mathematical treatise into one which actually explains music. In this way Aristoxenus' musical exposition has its own influence on the scope of Pythagorean theory and makes a difference to musicology in a way that the apparently erratic and easily dismissed demonstrations of the *harmonikoi* does not. Whilst it may be true that Aristoxenus' treatise never succeeds in removing Pythagorean speculation about the numerical relationships inherent in musical structures from the science of harmonics, it extends the discussion of musical experience and establishes a language for describing musical phenomena.

Similarly, although Pythagorean methodology remains dominant for the greater part of antiquity, Aristoxenus' exposition of musical space is never successfully suppressed. His insistence that music could be described as it was perceived by an audience was widely accepted. While most mathematical theorists recognised the fallacy of Aristoxenus' interval measurements, they nevertheless used his terminology as a preliminary way to distinguish the genera.

The dependence of most authors after Aristoxenus on the work of previous scholars and the presentation of earlier expositions resulted in a programme essentially unchanged through successive generations. This raises doubts about the reality reflected by theoretical investigation, as it is not likely that musical practice did not change at all from the three genera presented by Aristoxenus to a substantially similar set of three genera presented hundreds of years later by Boethius. Yet only a few scattered comments throughout the entire corpus of ancient Greek musical theory refer to changes in performance practice.

While Aristoxenus' emphasis on how music is heard and the dynamic concept of musical elements is largely neglected in the Middle Ages, from the time of the Renaissance the dominance of an absolute and necessary framework for music analysis was fading. In modern constructs of musical theory, particularly as a harmonic and chordal understanding of music developed, the concept of a note's function within a scalar system resurfaced and has been, at least until the twentieth century, the primary method of explaining the structure of music.

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Conclusion

There are two principal elements which determine the success of Aristoxenus' attempt to establish an independent science of harmonics and, more broadly, of musicology. The first is a delimitative approach to the investigation of musical knowledge; the other is the development of an empirical language with which to describe musical phenomena. These two elements complement one another in Aristoxenus' attempt to separate the various musical sciences from one another and from other disciplines. His strict delineation of musical investigation as a whole into individual areas such as harmonics, rhythemics, organology, acoustics, education and history helped him move away from earlier universal or encyclopaedic perspectives.

The first half of this study examined the harmonic theory of Aristoxenus, for which he is most famous, and how it was developed from a variety of sources. Aristoxenus had two principal influences on his harmonic treatise: firstly, earlier musical theoretical investigation against which he reacted, and secondly, an Aristotelian theory of science around which he structured his methodological criteria. Aristotle's programme for a natural theoretical science capable of axiomatic expression (described principally in the *Posterior Analytics*), was adopted by Aristoxenus as the basis for his harmonic science. He appropriated the criteria from Aristotle's discussions on subject limitation, first principles and demonstrated propositions and applied them to his field, attempting to create an axiomatic science which could describe the organisation of musical space systematically and thoroughly without recourse to the laws of other disciplines.

Earlier approaches to harmonics had established two main techniques, the mathematical and the empirical. Aristoxenus rejected mathematical and acoustic techniques favoured by the Pythagoreans because of his strict application of Aristotle's scientific criteria. This rejection forced Aristoxenus to develop his own method for expressing the laws of harmonics through his ideas about continuity, succession and, eventually, *dynamis*. This final notion, that

a note is perceived as having a function within the scale system, is essential to Aristoxenus' empirical exposition of harmonics. On the other hand, his response to the selective demonstrations of the empirical *harmonikoi* was to construct his theory around their failures. The description of harmonic structures, based on a geometrical concept of musical space, is approached by Aristoxenus with a highly systematic methodology which separates his work from that of earlier empirical treatments.

Aristoxenus' emphasis on empirical terminology for the description of harmonic phenomena complements the division of musical space into separate branches. Indeed his further arrangement of harmonics into parts establishes the vocabulary of his science. This sevenfold list not only establishes the subjects to be treated but introduces the terms in which they are to be discussed. Empirical definitions of note, interval and *systema* isolate the constituent parts of musical sound, as they are perceived by the senses.

The development of Aristoxenus' theory is evident in the revision between Books I and II of the *Harmonics*. The refining of his theory, particularly its stricter exclusion of extraneous material, shows how Aristoxenus develops the divisive techniques which he applies to music as a whole. Admittedly, the argument for the revision of Book I is only strong in the internal evidence of the treatise, and it is not entirely supported by the external evidence. However, the problems of asserting this structure can be overcome if one accepts that the introductory section of Book I had formed part, or was intended to form part, of another, more preliminary work on the material of musical sound.

Aristoxenus was nonetheless clearly capable of applying different methodologies to various subjects and the second half of this study investigated how he approached subjects outside the field of harmonics. His other technical treatise, the *Rhythmics*, from which an extended fragment survives, shows significant methodological similarities to the *Harmonics*. Furthermore, Aristoxenus was not just an author of music theory, as his historical, and educational writings on music indicate. His approach to the subjects of harmonics and rhythmics as parts of a broader field is also evidenced in the fragmentary remains of Aristoxenus' works which relate to less strictly technical elements of music. The examination of these fragments, which cover such areas as historical development, social function, organology and geographically-defined musical customs demonstrate the fact that Aristoxenus' ability as a musicologist is considerably broader than that which we see of him in the *Harmonics*.

While some of the material of one musical subject may overlap another, the emphasis of different aspects seem to depend on the purpose of the treatment. However, despite his competent treatments of various musical subjects,

it is only in harmonics that his work is truly innovative. Consequently, it is this work which makes the greatest impact on later musical theory.

In creating these different musicological methods according to the appropriate treatment of a subject, Aristoxenus drew on several philosophical sources. His work shows the influence of Aristotle: the scientific techniques promoted—but not necessarily applied—by Aristotle were used as a foundation of an axiomatic science for harmonics, and perhaps for rhythmic too. Another aspect of Aristotle's philosophy is evident in the encyclopaedic methods which appear to have been the basis of Aristoxenus' works on instruments and musical traditions. Other areas of his investigation show the influence of Pythagorean origins, such as in the study of acoustic phenomena, even though he did not accept the relevance of acoustic theories to harmonics.

The effect of Aristoxenus' work is evident in the musical theory which followed his treatise, and although he is an authority for information on a wide range of musical data, his real influence is in harmonic theory. His innovations in this subject have affected not only the empirical techniques of those who would be classified as Aristoxenians but also the theories of the so-called Pythagorean school. Aristoxenus' divisive programme for musical analysis works particularly well for harmonic science and it is adopted in various ways by almost all later theorists, and his descriptive analysis of the matter out of which melodic sound is formed is universally accepted. His attempt at axiomatic science is, however, not as successful. Frequent criticism about Aristoxenus' perception of intervals contrasts with the absolute authority which he appears to maintain in general musical issues and in the eyes of non-specialist musicologists.

This study has concentrated on the musical writings of Aristoxenus, but there is material outside this field which would be worthy of further investigation. Of particular interest is his promotion of the Pythagorean school, and a detailed analysis of *ho mousikos* as a Pythagorean, compared to his persona as a musician, would probably extend our understanding of his educational works. In this regard, his role in the establishment of the genre of biography, and therein his extensive praise of prominent members of the Pythagorean school, should also be analysed. In addition, one could examine Aristoxenus' rather limited adoption of, and adherence to, Aristotelian scientific and encyclopaedic techniques despite his aspiration to the leadership of the Lyceum.

Aristoxenus' singular role in the development of musical science also prompts questions about the extent of the existence of comparable innovators in other areas of Greek science. A preliminary overview would acknowledge the existence of Herodotus in narrative history, Galen in medicine, Euclid in geometry, but perhaps further investigation would present some significant

parallels between these figures and the development of particular branches of science. Equally, an analysis of the cross-contamination of the historical documentation concerning the innovations by particular individuals and the attribution of all doctrines to a single figure, such as Pythagoras or Hippocrates may illuminate the various ways in which scientific methodology is developed.

The achievements of Aristoxenus of Tarentum in the field of musical analysis demonstrate an individual making a significant impact on the development of a subject's methodology. The remarkable advance in musical theory apparent in the *Harmonics* and the influence which it subsequently had over the works which followed show how richly Aristoxenus deserved the epithet ὁ μουσικός.

Notes

NOTES TO INTRODUCTION

1. The role of music in Greek life has been extensively discussed for example by West (1992), Mathiesen (1999) and Anderson (1994).
2. This epithet appears many times among the fragments of Aristoxenus (Wehrli, 1967) in both Greek and Latin sources. A selection of examples includes: Apollonius *Historiae Mirabiles* 30, 40 and 49 (Frs. 134, 117 and 6); Athenaeus XII 545a (Fr. 50); Cicero *Disputations* I 10.19 (Fr. 120a); Diogenes Laertius V 92 and VIII 14 (Frs. 114 and 24); Dionysius of Halicarnassus *De Compositione Verborum* 72 (Fr. 88); Eusebius *Preparation for the Gospel* XI 3 and XV 2 (Frs. 53 and 64); Gellius *Noctes Atticae* IV 11 (Fr. 25); Lucian, *De Parasito* 34–35 (Fr. 62); Plutarch *Timoleon* XV and *Aristides* XXVII (Fr. 32 and 58).
3. The German term *Musikwissenschaft*, according to the Oxford Dictionary of Music, was first used by Logier in 1827 and was transferred into English through the French equivalent *musicologie*. The dictionary further defines musicology as “all study of music other than that directed to proficiency in performance or composition.” s.v. Musicology.
4. Fr. 1, Suda s.v. **ΑΡΙΣΤΟΞΕΝΟΣ**. Trans. after Laloy (1904, p. 2)
5. The confusion concerning the identity of Aristoxenus’ father is solved adequately by Laloy (1904, p. 2–3) who notes that Sextus Empiricus (VI 1) and Fr. 59, Diogenes Laertius (II 20) both name Spintharos. Less convincingly, Wehrli (1967, p. 47) concludes that Aristoxenus’ father is Mnesias and that the relationship with Spintharos was educational and professional. Others (Visconti 1999, p. 12; Macran 1902, p. 86) note him as Mnesias, also called Spintharos.
6. Cf. Ps.-Plutarch 1142c–f and Laloy (1904, p. 8–9). Aristoxenus’ favourable interest in this city’s customs is evidenced by Philodemus in the **Περὶ εὐσεβείας** 18 (Fr. 45, I).

NOTES TO CHAPTER ONE

1. Cf. Suda s.v. *Λόσος* and Martianus Capella (IX 936); cf. West (1992) p. 225 and Lasserre (1954) p. 34 ff.
2. In particular cf. Plato *Republic* Book III and *Laws*, Books II, III and VII; Aristotle *Politics* Book VIII.
3. The term *dynamis* (δύναμις) has a variety of meanings ranging from power, might, or force to ability, faculty, or potential. Aristoxenus uses it to refer to his conception of the role of a musical note within a system, rather than the exact measurement of intervals, and it is often translated in a musical context as 'function.'
4. This means that two sonorous strings of lengths in these ratios will sound at these intervals if all other things (such as the thickness and the tension) are equal. More simply, one piece of string twice as long as another piece of string will sound an octave lower than it.
5. A basic bibliography covering Pythagorean musicology would include: Barbera (1984a), (1984c); Barker (1981b), (1989a) p. 1–52, (1989b); Bowen (1982), (1991); Burkert (1972); Comotti (1991); Izzo (1987); Mathiesen (1975); Van der Waerden (1943); Zaminer (1979–80).
6. The titles of works on Pythagorean subjects are found in Wehrli: Frs. 11–41 Πυθαγόρου βίος, Περὶ Πυθαγόρου καὶ τῶν γνωρίμων αὐτοῦ, Περὶ τοῦ Πυθαγορικοῦ βίου, and Frs. 47–50 Ἀρχύτα βίος.
7. Burkert (1972) comments on the mystical aspect of the connections established by the Pythagoreans: "The earliest Pythagorean musical theory is not founded on mathematics or on experimental physics, but on "reverence" for certain numbers in their roles in music and cosmology; and this situation is never completely abandoned." p. 400. Cf. also Lippman (1964) Ch. 1 esp. p. 7–9.
8. "Since, again, they saw that the attributes and ratios of the *harmoniai* are found in numbers; since, finally, all other things seemed to have been framed, in their whole nature, in the likeness of the numbers, and of all nature the numbers seemed to be first things, they supposed that the elements of numbers are the elements of all things, and the whole heaven is a *harmonia* and a number." *Metaphysics* 985b32–986a3; trans. Barker (1989a) p. 32. Cf. Huffman (1993) p. 57–64 on the probability of Philolaus as the main source for Aristotle on Pythagorean doctrine.
9. "It is clear from these points that the thesis that a *harmonia* occurs when the stars move, on the grounds that the sounds arising are concordant, though it is elegantly and strikingly stated by those who enunciate it, is nevertheless not true." *De Caelo* 290b12–15; trans. Barker (1989a) p. 33.
10. "It appears, I said, that just as the eyes are fixed on astronomy, so the ears are fixed on harmonic motion, and that these two sciences are one another's sisters, as the Pythagoreans say and we agree, Glaucon." *Republic* 530d; trans. Barker (1989a) p. 55. Further evidence is given by Sextus Empiricus: ὁ

σύμπας κόσμος κατὰ ἁρμονίαν διοικεῖται, ἡ δὲ ἁρμονία σύστημα ἔστι τριῶν συμφωνιῶν, τῆς τε διὰ τεσσάρων καὶ τῆς διὰ πέντε καὶ τῆς διὰ πασῶν. “[The Pythagoreans say that] the whole universe is organised on the basis of these numbers according to *harmonia*; and *harmonia* is a *systema* of three concords, the fourth, the fifth and the octave;” *Adversus Mathematicos* VII 95; trans. Barker (1989a) p. 30.

11. As Kirk and Raven noted: “Pythagoras was interested in science as well as in the fate of the soul. Clearly too religion and science were, to Pythagoras, not two separate departments between which there was no contact, but rather the two inseparable factors in a single way of life . . . The central notions, which held together the two strands that were later to fall apart, seem to have been those of θεωρία (contemplation), κόσμος (an orderliness found in the arrangement of the universe) and κάθαρσις (purification). By contemplating the principle of order revealed in the universe—and especially in the regular movements of the heavenly bodies—and by assimilating himself to that orderliness, man himself was progressively purified until he eventually escaped from the cycle of birth and attained immortality.” Kirk and Raven 1st ed. (1957) p. 228. This combination of *theoria*, *kosmos* and *katharsis* allowed music to assume an important role in the thinking of the Pythagoreans, not investigated in its own right, but considered as a contribution to the total well-being of the soul.
12. The passage on dualism is from the above-mentioned discussion of Aristotle on the Pythagoreans: ἕτεροι δὲ τῶν αὐτῶν τούτων τὰς ἀρχὰς δέκα λέγουσιν εἶναι τὰς κατὰ συστοιχίαν λεγομένας, πέρας [καὶ] ἄπειρον, περιττὸν [καὶ] ἄρτιον, ἓν [καὶ] πλῆθος, δεξιὸν [καὶ] ἀριστερόν, ἄρρεν [καὶ] θῆλυ, ἡρεμοῦν [καὶ] κινούμενον, εὐθύ [καὶ] καμπύλον, φῶς [καὶ] σκότος, ἀγαθὸν [καὶ] κακόν, τετράγωνον [καὶ] ἑτερόμηκες. “Other members of this same school say there are ten principles, which they arrange in two columns of cognates—limit and unlimited, odd and even, one and plurality, right and left, male and female, resting and moving, straight and curved, light and darkness, good and bad, square and oblong” *Metaphysics* 986a22–26; trans. Ross (1910). Aristotle’s table of opposites is discussed in Burkert (1972) p. 51–2.
13. This point is also highlighted by Aristotle: οἱ δὲ Πυθαγόρειοι πρότερον περὶ τινῶν ὀλίγων, ὧν τοὺς λόγους εἰς τοὺς ἀριθμοὺς ἀνήπτον, οἶον τί ἐστι καιρὸς ἢ τὸ δίκαιον ἢ γάμος. “The Pythagoreans had before this treated of a few things, whose formulae they connected with numbers—e.g. opportunity, justice, or marriage” *Metaphysics* 1078b21–3; trans. Ross (1910). Cf. also *Metaphysics* 985b26 ff. and 1090a20 ff.
14. The number 10 had an elevated significance in Pythagorean thought. Cf., e.g., Actius: εἶναι δὲ τὴν φύσιν τοῦ ἀριθμοῦ δέκα. μέχρι γὰρ τῶν δέκα πάντες Ἕλληνες, πάντες βάρβαροι ἀριθμοῦσιν, ἐφ’ ἃ ἐλθόντες πάλιν ἀναποδοῦσιν ἐπὶ τὴν μονάδα. καὶ τῶν δέκα πάλιν, φησὶν (sc.

Pythagoras), ἡ δὴ δύναμις ἐστὶν ἐν τοῖς τέσσαρσι καὶ τῇ τετράδι. τὸ δὲ αἴτιον· εἴ τις ἀπὸ τῆς μονάδος [ἀναποδῶν] κατὰ πρόσθεσιν τιθεῖ τούς ἀριθμούς ἄχρι τῶν τεσσάρων προελθὼν ἐκπληρώσει τὸν <τῶν> δέκα ἀριθμόν· “Ten is the very nature of number. All Greeks and all barbarians alike count up to ten, and having reached ten revert again to the unit. And again, Pythagoras maintains, the power of the number ten lies in the number four, the tetrad. This is the reason: if one starts at the unit and adds the successive numbers up to four, one will make up the number ten;” I 3, 8; text DK 58B15; trans. Kirk and Raven (1957) p. 230–1. Cf. Aristotle ἐπειδὴ τέλειον ἡ δεκάς εἶναι δοκεῖ καὶ πᾶσαν περιελήφεναι τὴν τῶν ἀριθμῶν φύσιν. “. . . as the number 10 is thought to be perfect and to comprise the whole nature of numbers.” *Metaphysics* 986a8–9; trans. Ross (1910).

15. An epimoric ratio is such that the greater term is equal to the smaller term plus an integral ‘part’ or ‘factor’ of the smaller term. All such ratios have the form $n + 1:n$.
16. The octave is problematic in that it is not epimoric but multiple, as Proposition 10 (158.8) of the Euclidean *Sectio Canonis* demonstrates. The other problem with this interval is the fact that the number one is not considered to be an odd number by the Pythagoreans (cf. Archytas in Theon of Smyrna 20.19 and 22.5–10 (DK 47A20 and 21); also Aristotle *Metaphysics* 986a20). Nevertheless the importance of epimoric intervals is maintained, particularly because multiple intervals (octave 2:1, twelfth 3:1, double octave 4:1) very quickly become larger than the range of around 2 octaves within which Greek music theory operates.
17. Nicomachus (*Enchiridion* Ch. 6), as far as the evidence goes, is the first to tell this much repeated story. Cf. Levin (1975) p. 86–7. One of the alternative versions which omits reference to hammers is from Xenocrates through Heraclides and cited by Porphyry who connects to Pythagoras this discovery of ratio-interval calculations: Πυθαγόρας, ὥς φησι Ξενοκράτης, εὗρισκε καὶ τὰ ἐν μουσικῇ διαστήματα οὐ χωρὶς ἀριθμοῦ τὴν γένεσιν ἔχοντα· ἐστὶ γὰρ σύγκρισις ποσοῦ πρὸς ποσόν. ἐσκοπεῖτο τοίνυν, τίνος συμβαίνοντος τὰ τε σύμφωνα γίνεται διαστήματα καὶ τὰ διάφωνα καὶ πᾶν ἡρμοσμένον καὶ ἀνάρμοστον. “Pythagoras, as Xenocrates says, discovered the intervals in music do not come into being apart from number; for they are an interrelation of quantity with quantity. So he set out to investigate under what conditions concordant intervals come about, and discordant ones, and everything well-attuned and ill-attuned.” Porphyry 30.2–6; trans. Barker (1989a) p. 235.
18. Van der Waerden (1943) p. 172–3 argues that this is possible on account of references to musical instruments such as the syrinx and harp in the Aristotelian *Problemata* (late fourth century, but perhaps reporting long held knowledge). Also Barker (1989a) p. 256 n. 43 notes that although the most

common stringed instruments, lyres and kitharas were not conducive to these discoveries because they have strings of the same length, harps were constructed with strings of various lengths.

19. Although there is evidence for this in Iamblichus, it cannot be said to be reliable. εὕρημα δ' αὐτὴν φασιν εἶναι Βαβυλωνίων καὶ διὰ Πυθαγόρου πρώτου εἰς Ἑλλήνας ἔλθειν. εὕρισκονται γοῦν πολλοὶ τῶν Πυθαγορείων αὐτῇ κεχρημένοι ὥσπερ Ἀρισταῖος ὁ Κροτωνιάτης καὶ Τιμαῖος ὁ Λοκρὸς καὶ Φιλόλαος καὶ Ἀρχύτας οἱ Ταραντῖνοι καὶ ἄλλοι πλείους, καὶ μετὰ ταῦτα Πλάτων ἐν τῷ Τιμαίῳ . . . "They say that it [musical proportion] is a discovery of the Babylonians and through Pythagoras first came to the Greeks. At least, many of the Pythagoreans are found to have used it, such as Aristaeus of Croton, Timaeus of Locri, Philolaus and Archytas of Tarentum, and many others, and after this Plato in the *Timaeus* . . ." Iamblichus *On Nicomachus' Arithmetical Introduction* 118.23; text Pistelli (1975); trans. Huffman (1993) p. 167–8.
20. Theon of Smyrna 59.4–21 (DK 18.13). The passage of Theon is disrupted by a lacuna, and it is not certain that he attributes the procedure with vessels to Lasus. Aristoxenus *Harmonics* 3.20–23 mentions of Lasus that he (mistakenly) thought notes to have had breadth. Lasus may not actually have been part of the Pythagorean school, which would explain to an extent why he is a target for Aristoxenus' complaints about past musical theorists from which Pythagoreans are generally exempt.
21. On Hippasus (early fifth century) and Glaucus (late fifth century) cf. Scholia to Plato *Phaedo* 108d (DK 18.12), Barker (1989a) p. 30, Wehrli (1967) Fr. 90; Comotti (1991) p. 23–24. Glaucus also wrote *Περὶ τῶν ἀρχαίων ποιητῶν τε καὶ μουσικῶν*, used by Ps.-Plutarch in his *De Musica* (cited specifically at 1132e, 1133f, 1134d, 1134f).
22. Philolaus Fr. 6 (Nicomachus *Enchiridion* Ch. 9 (DK 44B6)). Cf. Huffman's commentary on this fragment (1993) p. 145 ff. He notes (p. 149) that the archaic language in the fragment testifies to its authenticity. Philolaus calls the fourth *syllaba*, the fifth *di'oxeia* and the octave *harmonia* rather than the terms which were later more common, respectively *dia tesseron*, *dia pente* and *dia pason* (the expression *dia pason* does in fact replace *harmonia* once in Fr. 6). The 256:243 interval remaining of the fourth after two 9:8 tones have been subtracted from it, Philolaus calls the *diesis* rather than the more usual *leimma* (remainder).
23. Much of Greek musical theory describes all or part of a standard scale system which was based around the tetrachord or fourth. The fourth, as the smallest consonant interval, was conventionally divided into three intervals, the exact size of which was subject to continual debate throughout antiquity.
24. Nicomachus *Enchiridion* 263.24–264.5. The term *diesis* (δίεσις, 'a letting through') refers to an interval of various sizes. It can as here, refer to the remainder of the fourth after two 9:8 tones have been taken out of it, that is,

the interval 256:243. More commonly and almost universally in later theorists, *diesis* refers to the smallest interval of the enharmonic tetrachord. It is understood to approximate a quarter tone and in some theorists is the unit of measurement for all other intervals. Aristoxenus describes the smallest enharmonic *diesis* as a quarter tone and the smallest chromatic *diesis* as a third tone (*Harmonics* 46.3–8).

25. Musical proportion is represented by the series 12:9:8:6 which gives the ratios for the consonant intervals of fourth (4:3), fifth (3:2) and octave (2:1), and the ratio for the whole tone (9:8). Nicomachus *Introduction to Arithmetic* II 26.2 states that Philolaus attributes the appellation of the harmonic mean to its role in harmonic geometry, in particular in the cube (12 sides, 8 angles, 6 surfaces). As we have noted above (n. 19) Iamblichus *On Nicomachus' Arithmetical Introduction* 118.23 traces the discovery of musical proportion through Pythagoras back to the Babylonians.
26. Archytas is thought to have been a friend of Plato, but the assumption rests on the authenticity of Plato's seventh letter (350a); cf. eg. Lloyd (1990).
27. Archytas' discussion of sound appears in Porphyry 56.2–57.27 and Nicomachus *Introduction to Arithmetic* I 6.16–7.4. Its authenticity was questioned by Burkert (1972) p. 379–80, but by other scholars has been generally accepted: cf. Bowen (1982); Ciancaglini (1998); Huffman (1985).
28. Archytas Fr. 2; Porphyry 93.6–17. Cf. Barker (1989a) p. 42 and 46–49. The series 12:9:8:6 includes examples of both the harmonic and arithmetic mean. With three terms, the arithmetic mean occurs when the second term exceeds the third by the same amount as the first exceeds the second (12:9:6). The harmonic (or subcontrary) mean between two terms occurs when the part of the third term (6) by which the second term (8) exceeds the third is the same as the part of the first term (12) by which the first term exceeds the second. That is, 8 exceeds 6 by one third of 6; 12 exceeds 8 by one third of 12. The geometric mean (which does not occur in this series nor between epimoric intervals) occurs when the second term exceeds the third by the same proportion as the first exceeds the second. In musical terms this results in adjacent intervals of the same size, for instance consecutive octaves 4:2:1.
29. Archytas' proof that epimores cannot be divided by a geometric mean is preserved in Boethius *De Institutione Musica* III 11. Its similarity to Proposition 3 of the ps.-Euclidean *Sectio Canonis* (152.1 ff.) is noted by Heath (1921), who points out some minor differences p. 215–216. Cf. also Van der Waerden (1948) p. 181–187 who discusses how the passage on means relates to Archytas' own tetrachordal divisions.
30. Archytas Fr. 1 (DK 47B1): "They (the *mathematikoi*) have handed down to us a clear understanding of the speed of heavenly bodies and their risings and settings, of geometry, of numbers, and not least of music. For these sciences seem to be sisters." Porphyry 56.8–10; trans. Barker (1989a) p. 40.

31. "They do the same as those concerned with astronomy: they seek the numbers in these heard concords, but to not rise to the problems, to investigate which numbers are concordant and which are not, and why each are so . . . it is at any rate useful . . . in the quest for the fine and good, whereas if pursued in any other way it is useless." *Republic* 531c; trans. Barker (1989a) p. 56. Cf. Barker (1978c), also Barbera (1981). Barker (1989b) also discusses the relevance of the date of the setting of the dialogue and a possible reference to the intervals of Archytas. The suggestion is compelling but we can see from the *Timaeus* how Plato takes his own discussion to the next level, referring to a numerical series, supposedly consonant within itself when taken outside of a musical context, something which Archytas does not seem to have done.
32. A connection between this structure and those involved in human music-making is indicated, however, at *Timaeus* 47c-e, 80b.
33. This is mentioned by Ptolemy (44.1) as a technique of musicians. Cf. Van der Waerden (1948) p. 187–191.
34. Boethius *De Institutione Musica* III 8. Cf. Huffman (1993) p. 364–374 on the credentials of Philolaus' fragments conserved by Boethius. Huffman's arguments effectively undermine those of Burkert (1972, p. 386–400), who regards the Boethius material as genuine.
35. As we shall see in the final chapter, Ptolemy in the second century CE made use of the means discussed by Archytas in his own interval calculations and his results reflect a much greater concern with transparent mathematical symmetry than those of earlier scholars. His theory places absolute emphasis on epimoric ratios even to the extent of creating a tetrachordal division of quite homogenous epimoric intervals 12:11 11:10 10:9 (38.13–39.6), which seems unlikely to reflect any actual musical practice.
36. "[Archytas of Tarentum], of all the Pythagoreans the most dedicated to the study of music, tried to preserve what follows the principles of reason not only in the concords but also in the divisions of the tetrachords, believing that a commensurable relation between the excesses is a characteristic of the nature of melodic intervals." Ptolemy 30.9–14 (DK 47A16); trans. Barker (1989a) p. 304.
37. ". . . patently out of tune with what has already been accepted by the senses." Ptolemy 30.15–16; trans. Barker (1989a) p. 304.
38. Winnington-Ingram (1932) points out that their calculations differ only by a matter of a few cents. (In equal-temperament, the octave measures 1200 cents, and is divided into twelve semi-tones of 100 cents each. A few cents difference is barely perceptible.)
39. *Harmonics* 23.11–23.
40. For details of this hypothesis see Winnington-Ingram (1932) p. 205–7. Winnington-Ingram notes that the disjunctive tone of 9:8 plus Archytas' lower interval of 28:27 equals an interval of 7:6, which is approximately equivalent to five *dieses*. On *ekbole* see Aristides Quintilianus *De Musica*

- 28.1–7. Bacchius Geron *Introduction to the Art of Music* 37, 41 and 42 associates the intervals *eklysis* (lowering the interval by three *dieses*) and *ekbole* with the enharmonic system. On these intervals in Bacchius see Solomon (1980). Ps.-Plutarch *De Musica* 1141b mentions (but does not describe) the *eklysis* and the *ekbole*, associating them with Polymnestos, a musician of the seventh century, and thereby indicates the antiquity of the intervals.
41. Barker (1989a) p. 46–52 and (1989b) p.162–3, 175.
 42. It is more likely, however, that Aristoxenus passed the information on to Aristotle, who seems to have found it plausible but not to have delved too deeply into the mathematics of it. Ps.-Plutarch 1139b-f provides some evidence although it is doubtful. Cf. Barker (1981a) on the passage of *De Anima* 424a17–424b19 which contains a reference to *logos/ratio* and to *aisthesis* as a general faculty of perception. Barker concludes that Aristotle's ideas are a little hazy on the definition of a consonant interval as one heard as a single entity, while the elements of a dissonant interval maintain their separate perceptible identity.
 43. The diatonic structure in the *Timaeus* may already have been described by Philolaus, though this conclusion is not guaranteed by the evidence.
 44. "What we mean by pitch is something like the voice's stability, or standing still. Let us not be disturbed by the opinions of those who reduce notes to movements, and who say quite generally that sound is movement." *Harmonics* 12.1–7. All citations from the *Harmonics* are from Barker (1989a).
 45. Archytas Fr. 1 (DK 47B1): [φωναὶ] τὰ μὲν ὑπὸ τῷ ἰσχυρῷ τῷ πνεύματος φερόμενα μεγάλα τε ἦμεν καὶ ὀξεῖα, τὰ δ' ὑπ' ὀσθενέος μικρὰ τε καὶ βαρέα. "[Voices] travelling under the agency of a strong breath are loud and high-pitched, while those travelling under the agency of a weak breath are quiet and low-pitched." Porphyry 57.10–11; trans. Barker (1989a) p. 41.
 46. This is seen also in the discussion of the movement of the voice in relation to singing and speech, *Harmonics* 9.2–12.
 47. Barker (1978a).
 48. Wallace (1995).
 49. It is this second group which seem to be criticised in the *Hibeh Papyrus* on music.
 50. Aristotle also makes a few comments on the science of *harmonics*: on harmonics as a natural branch of mathematics *Physics* 194a8; on the nature of the sciences of optics and harmonics in *Metaphysics* 997b21; 1077a5; 1078a14.
 51. Porphyry 62.3–4 = Fr. 716 Fortenbaugh. Theophrastus also mentions *harmonikoi* in his *Characters* (5.10) among sophists and arms-instructors.
 52. "Again, it is not the intervals, as some people say, that are the causes of the differences and hence their principles, since if these are left out the differences still remain. For when something comes into being if certain things are left out, these are not the causes of its existence, not as productive causes, but

- [only] as things that do not prevent it." Porphyry 64.24–27 trans. Barker (1989a) p. 117.
53. The proposition that Aristoxenus' technique of musical analysis was based on the newly developed science of geometry is established by Crocker (1966) and adopted by several scholars including Barbera (1977), Litchfield (1988) and Barker (1991c).
 54. *Republic* 531a–c.
 55. Phainias (Fr. 32 Wehrli; Athenaeus VIII 352c) mentions Stratoniceus as the first to construct a "diagram" and to teach *ta harmonika*. Cf. West (1992) p. 218.
 56. "Others delivered oracular utterances on individual topics, without giving explanations or demonstrations, and without even properly enumerating the perceptual data." *Harmonics* 32.28–31.
 57. "[It] is just like the way the days of the month are counted, where, for example, what the Corinthians call the tenth the Athenians call the fifth, and others again the eighth. In just the same way, some of the harmonicists say that the Hypodorian is the lowest of the *tonoi*, the Mixolydian a semitone higher, the Dorian a semitone above that, the Phrygian a tone above the Dorian, and similarly the Lydian another tone above the Phrygian. Others add below the ones mentioned the Hypophrygian *aulos*; while others again, with an eye to the boring of the finger-holes of the *auloi*, separate the three lowest *tonoi*, the Hypophrygian, the Hypodorian and the Dorian, by three *dieses* from one another, and the Phrygian from the Dorian by a tone, placing the Lydian at a distance of another three *dieses* from the Phrygian, and the Mixolydian at the same distance from the Lydian. But what the grounds are on the basis of which they have persuaded themselves to separate the *tonoi* in this way, they have not told us." *Harmonics* 37.13–38.3.
 58. Cf. Winnington-Ingram (1936) p. 71 ff. and West (1992) p. 228–9.
 59. "As to the objective that people assign to the science called harmonics, some say that it lies in the notation of melodies, claiming that this is the limit of the comprehension of each melody, while others locate it in the study of *auloi*, and in the ability to say in what manner and from what origin each of the sounds emitted by the *aulos* arises." *Harmonics* 39.3–12.
 60. On notation cf. Barbour (1960) and Chailley (1967).
 61. Cf. Barker (1989a) p. 156 n. 46, and Poriron (1964). On the other hand West (1992) p. 264 claims that Aristoxenus' description can be reconciled with the notation transmitted by Alypius, as does Macran (1902) p. 270–2.
 62. "... one would only have to submit a melody to the *aulos* for it to be at once immutable, infallible and correct." *Harmonics* 42.19–20.

NOTES TO CHAPTER TWO

1. The doctrine of musical *cthos* appears to go back to Damon. Cf. Wallace (1991).
2. *Posterior Analytics* 75b14–17.

3. *De Sensu* 439b19–440a4.
4. *De Sensu* 448a8–11.
5. “In these cases it is the task of those who use perception to know the fact that, and that of the mathematical scientists to know the reason why: for the latter possess the demonstrations of the causes, and often do not know the fact that, just as people who study the universal often do not know some of the particular instances because they have not observed them.” *Posterior Analytics* 79a3–7; trans. Barker (1989a) p. 71–2.
6. *Metaphysics* 1053a10–16. Cf. Vetter (1936) p. 10–12 on Aristotle’s various understandings of the *diesis*, also Bélis (1986) p. 69–72 on the *diesis* as a common measure in Aristotle’s work.
7. “In music the measure is the *diesis*, since it is the smallest, and in speech it is the letter.” *Metaphysics* 1053a10–14; trans. Barker (1989a) p. 72–3. Cf. *Metaphysics* 1016b18–24 and *Posterior Analytics* 84b37–9.
8. “. . . But the measure is not always numerically one. Sometimes there are several, as for instance there are two *dieses*—not those given by the ear, but those found in ratios.” *Metaphysics* 1053a14–16; trans. Barker (1989a) p. 73.
9. In the *Harmonics* Aristoxenus accepts that the *diesis* varies in size depending on the genus (21.20–31 and 46.3–8). Outside a genera context, for example in discussing the *katapyknosis* diagrams of the *harmonikoi*, Aristoxenus understands a quarter-tone interval for the *diesis*.
10. The *pyknon* (‘compression’) is the sequence of two small intervals (*dieses*) at the bottom of the enharmonic and chromatic tetrachords. The *pyknon* is said to exist if the sum of these two intervals is smaller than the remaining interval of the fourth. It is the dividing marker between the chromatic and diatonic genera, and a tetrachord is diatonic if the sum of its two lower intervals is greater than one and a quarter tones.
11. Boethius *De Institutione Musica* III 11.
12. Ptolemy *Harmonics* 70.10–74.3.
13. Boethius *De Institutione Musica* III 8.
14. That is 256:243 9:8 9:8.
15. For discussions of the passage see, among others: Handschin (1950) p. 7–8; Lippman (1964) p. 24–5; Moutsopoulos (1959) p. 348 ff.
16. *Metaphysics* 1093a28–b4 Aristotle states that the *mesai* are represented by 8 and 9, indicating his familiarity with this division of the octave, represented by the numerical series 6, 8, 9, 12. More than once in the *Posterior Analytics* Aristotle remarks on the subordination of harmonics to arithmetic, and compares it to the way in which optics is subordinate to geometry (75b14–17, and 78b34–79a4). Specifically, in relation to intervals Aristotle asks himself: τί ἐστὶ συμφωνία; λόγος ἀριθμῶν ἐν ᾧ οἷ καὶ βαρεῖ. “What is concord?—a ratio of numbers between the high-pitched and the low-pitched.” *Posterior Analytics* 90a19–20; trans. Barker (1989a) p. 60.
17. Cf. Richter (1983).

18. Such experiments appear to have been conducted in the peripatetic school to judge from the evidence of the Ps.-Aristotelian *Problems* Book 19, Questions 23, 35, and 50. Aristotle refers to the apparent connection between numbers and musical intervals, *Metaphysics* 985b32-986a3.
19. "Again, it is not the ideal numbers that are the causes of musical phenomena and the like (for equal ideal numbers differ from one another in form; for even the units do); so that we need not assume Ideas for this reason at least." *Metaphysics* 1093b21-24; trans. Ross (1910).
20. *De Sensu* 448a8-11. Cf. Barker (1981a) on Aristotle's understanding of the relationship between perception and the perceived object. Barker discusses this passage as well a related passage from *De Anima* 424a17-b19.
21. "Nor can combined objects be simultaneously perceived (for they are ratios of opposites, e.g., the chord of the octave or the fifth), unless they are perceived as one." *De Sensu* 448a8-11; trans. Hett (1936).
22. Barker (1981a) p. 251. There is pre-Aristotelian evidence at Plato *Timaeus* 80b; cf. *Symposium* 187a-c.
23. Cf. Lynch (1972) p. 84-90.
24. "The investigation of truth is in one way hard, in another easy. An indication of this is found in the fact that no one is able to attain the truth adequately, while, on the other hand, no one fails entirely, but every one says something true about the nature of things, and while individually they contribute little or nothing to the truth, by the union of all a considerable amount is amassed." *Metaphysics* 993a30-b4; trans. Ross (1910). Many of Aristotle's works also contain such a critique of previous scholarship including the *Physics* (184b15 ff.), *De Caelo* (throughout), and *De Anima* (403b20 ff.).
25. For example see Fraser (1994) for a description of Theophrastus' opportunities and methods for accumulating information for his work in biology.
26. Gottschalk (1968) discusses the authorship of the treatise, disputing the other possibilities of Heraclides Ponticus and Theophrastus, before concluding that the most likely candidate is Strato. Although Barker (1989a) p. 98 accepts Strato as a candidate for authorship of the work, he does not entirely support Gottschalk's thesis on the basis that Porphyry's attribution of the work to Aristotle has not been disproved.
27. For a summary and discussion of the contents of the *De Audibilibus* and other peripatetic works on acoustics cf. Lippman (1964) p. 142 ff.
28. "For if every interval were a quantity, and if melody arose from differences between notes, the melody would be as it is because it is a number. But if it were nothing but a number, everything numerable would participate in melody too, to the extent that it does in number." Porphyry 62.7-10; trans. Barker (1989a) p. 112. On the musical ideas of Theophrastus see Lippman (1964) p. 157 ff.; cf. Barker (1977) for some textual notes and comments on Düring's edition of Theophrastus.
29. *Metaphysics* 1093a1 ff.

30. *Historia Plantarum* IV II.1–7.
31. The question of who was the audience for these texts is uncertain. I am assuming that the works of the peripatetic school were written lectures, aimed at the students of the school.
32. Fr. 1, Suda s.v. Ἀριστόξενος.
33. Bélis (1986) focuses on the variety of influences which Aristotle had on Aristoxenus' *Harmonics*; cf. p. 210 ff. in relation to the *Posterior Analytics*; cf. also Barker (1991a) on the dependence of Aristoxenus on the methods described in the *Posterior Analytics*.
34. For a description of axiomatic science as developed by Aristotle in the *Posterior Analytics* cf. Scholz (1975).
35. This thesis was the basis for Barnes' (1969) article on demonstrative science in Aristotle; cf. also Lloyd (1996) Ch. 1; Bolton (1987).
36. Jaeger (1952). This idea that Aristoxenus uses Aristotle's scientific methods has also been developed in Bélis (1986) p. 37–59, 116–124, who argues that Aristoxenus draws on Aristotle's *Physics*. Barker (1991a), who sees the programme of the *Posterior Analytics* in Aristoxenus' treatise, also develops this thesis.
37. Barker calls this the "same domain" theory; cf. Barker (1989a) p. 67–8 and, in more depth, Barker (1991a) p. 201 ff.
38. Eg. *Posterior Analytics* 76a10–13.
39. *Posterior Analytics* 79a3–7.
40. *Metaphysics* 1064a10–19, cf. also *Topics* 145a15–16. In the *Metaphysics* theoretical science is also divided into three levels, the natural, mathematical and theological, the last of these being the highest.
41. For instance, the terms ἀρχή and αἰτία, which are discussed in *Physics* 194b16 ff. and *Metaphysics* 1012b33 ff., appear in the *Harmonics* several times including 32.31, 44.5, 54.20 (ἀρχή) and 5.14, 22.25 (αἰτία).
42. "For our study of the soul it is necessary, while formulating the problems of which in our further advance we are to find the solutions, to call into council the views of those of our predecessors who have declared any opinion on this subject, in order that we may profit by whatever is sound in their suggestions and avoid their errors." *De Anima* 403b20–24; trans. Smith (1931).
43. "When the objects of an inquiry, in any department, have principles, causes, or elements, it is through acquaintance with these that knowledge and understanding is attained." *Physics* 184a10–12; trans. Hardie and Gaye (1962). Cf. Mathiesen (1999) p. 303.
44. Assuming Macran's reading, see below n. 49.
45. "Since every science which consists of more than one proposition should adopt first principles from which the things dependent on these principles can be demonstrated, we must adopt such principles." *Harmonics* 44.4–7.
46. Less general techniques are also adopted by Aristoxenus from Aristotle; in particular the discussion on continuity (συνέχεια) and consecution (ἐξήης)

in the *Physics* (226b34 ff.) is comparable to that in the *Harmonics* (27.15, 52.33 and throughout Book III). These will be discussed in the following chapter. In addition, in a later chapter we shall examine the influence which Aristotle has had, to different effect, on Aristoxenus' scholarship, in the indirect evidence conserved in the Ps.-Plutarchean *De Musica*.

47. "A science is one if it is concerned with a single genus or class of objects which are composed of the primary elements of that genus and are parts of it or essential modifications of those parts." *Posterior Analytics* 87a38–40; trans. Tredennick (1960).
48. "It is not possible to give a demonstration by shifting from one class of things to another: for instance, one cannot demonstrate something in geometry by means of arithmetic." *Posterior Analytics* 75a38–40; Tredennick (1960); trans. Barker (1989a) p. 71.
49. "For it is the study of first principles, which include whatever is relevant to an understanding of *systemata* and *tonoi*" *Harmonics* 1.19–20; Macran (1902); trans. Barker (1989a). Barker follows Macran's text here rather than Da Rios. That of Da Rios follows the manuscript's τυγχάνει γὰρ οὕσα πρώτη τῶν θεωρητικῶν, but changes the manuscript's ταῦτα to ταύτης. "For it is the first of the theoretical sciences, of which . . ." This is not out of the question since Aristoxenus adheres to Aristotle's program for a theoretical science.
50. "The man who is proficient in this science should not consider anything beyond these [*systemata* and *tonoi*] as falling within his province." *Harmonics* 1.22–3.
51. "It is to be understood, speaking generally, as the science which deals with all melody, and enquires how the voice naturally places intervals as it is tensed and relaxed." *Harmonics* 32.10–14.
52. Cf. Cazden (1958) on the complementary roles of Pythagorean and Aristoxenian methods.
53. Barker (1991a) p. 214–215 and (1978b) p. 15–16. The intervals of quarter, third and semitone are defined according to their function in genera, respectively as the smallest enharmonic *diesis*, the smallest chromatic *diesis*, and the semitone (21.20–31). The genera are clearly enumerated at 50.19–52.31 using this functional terminology.
54. Ptolemy (32.19–20) also criticises Aristoxenus for this minute differentiation between intervals.
55. "Thus it is clear that the genus can remain constant while the magnitudes change, since up to a certain point the genus does not change when the magnitudes do, but remains the same: and while the genus remains constant it is reasonable to suppose that the functions of the notes do too." *Harmonics* 49.2–7.
56. ". . . for it is the study of first principles . . ." *Harmonics* 1.19; Macran (1902); trans. Barker (1989a). As we noted above n. 49, Da Rios' text says that it is

the first of the theoretical sciences. In any case, Aristotle associates theoretical sciences with those concerned with principles and causes.

57. As it is asserted in the very beginning of the *Physics* 184a10–12, noted above.
58. “. . . that all men suppose what is called wisdom to deal with the first causes and the principles of things. This is why, as has been said before, the man of experience is thought to be wiser than the possessors of any perception whatever, the artist wiser than the men of experience, the master-worker than the mechanic, and the theoretical kinds of knowledge to be more of the nature of wisdom than the productive. Clearly then wisdom is knowledge about certain causes and principles.” *Metaphysics* 981b27–982a3; trans. Ross (1910). Cf. Laloy (1904) p. 36 on the borrowing of the titles *Principles* and *Elements* from the opening lines of Aristotle’s *Physics* and Bélis (1986) p. 34–8 on the methods of the *Physics* and *Metaphysics* which appear in the *Harmonics*.
59. “For we do not think that we know a thing until we are acquainted with its primary causes or first principles, and have carried our analysis as far as its elements.” *Physics* 184a12–14; trans. Hardie and Gaye (1962).
60. καὶ τὴν τιμιωτάτην δεῖ περὶ τὸ τιμιώτατον γένος εἶναι. αἱ μὲν οὖν θεωρητικά τῶν ἄλλων ἐπιστημῶν αἰρετώταται. “And the highest science must deal with the highest genus, so that the theoretical sciences are superior to the other sciences.” *Metaphysics* 1026a21–23; trans. Ross (1910).
61. “We, on the other hand, try to adopt initial principles which are all evident to anyone experienced in music, and to demonstrate what follows from them.” *Harmonics* 32.31–33.1. There are some slight indications that Book I was also conceived with the Aristotelian framework in mind; see e.g. 5.33–6.11, 28.32–29.1. But these hints are not developed.
62. “. . . to be true, primary, immediate, better known than, prior to, and causative of the conclusion” *Posterior Analytics* 71b20–23; trans. Tredennick (1960).
63. “Sense-perception must be concerned with particulars, whereas knowledge depends upon recognition of the universal . . . If however, by observing repeated instances we had succeeded in grasping the universal, we should have our proof; because it is from the repetition of particular experiences that we gain our view of the universal.” *Posterior Analytics* 87b38–88a5; trans. Tredennick (1960). On the relationship between perception and knowledge in Aristotle and Aristoxenus see Bélis (1986) p. 210–216.
64. “Since many forms of melody, of all sorts, come into existence in notes which are themselves the same and unchanging, it is clear that this variety depends on the use to which the notes are put.” *Harmonics* 38.19–23.
65. That Aristoxenus’ chosen subject matter (melody) is not entirely appropriate to an axiomatic exposition is an important aspect in the assessment of the success of his treatise according to the aims he seems to have set for himself. This will be discussed in the following chapter.

NOTES TO CHAPTER THREE

1. Two early codices give the title of the first book as Ἀριστοξένου πρὸ τῶν ἁρμονικῶν στοιχείων. In some cases the πρὸ τῶν is corrected by a later hand to πρῶτον (first) and the titles of the other two books corrected from first and second to second and third. Cf. Da Rios (1954) p. cvii-cxi; Mathiesen (1999) p. 295–299.
2. Porphyry (80.22) cites the first book of the περὶ ἀρχῶν and clearly refers to a passage from Book I of the *Harmonics* 14.18–20.
3. Porphyry 28.22 (who may be quoting Didymus at this point), cites the introduction of the first book of the ἁρμονικῶν στοιχείων when he refers to the different roles of reason and perception, a distinction which does not occur in the *Harmonics* until Book II, 33.7–9; in 81.23 in the section of the commentary dealing with Ptolemy's discussion of the movement of the voice, Porphyry refers to the ἁρμονικῶν στοιχείων and states that Aristoxenus' exposition begins with the genera and not with notes. This can only refer to the second book of the *Harmonics* as Book I treats the movement of the voice, notes, intervals and *systemata* in that order; 124.15 refers to the first book of the ἁρμονικῶν στοιχείων and cites a passage from Book II of the *Harmonics* 45.2 ff.
4. (1954) p. cvii-cxvii.
5. "Sed haec minime, ni fallor, sufficiunt ut rerum dispositio in tres libros nobis tradita immutetur (aliud est enim hic illic quaedam reprehendere, aliud novum Aristoxenum arbitrio nostro producere)." "But unless I am deceived, these things are not sufficient that the disposition of matters in three books as handed down to us should be changed (for it is one thing to reprove certain things here and there but it is another to produce a new Aristoxenus by our judgement)." p. cxvii.
6. (1986) p. 24–48. The division in Book I comes clearly at 8.13 and in Book II after the initial list of the seven parts of harmonics. Despite the ingenuity of Bélis' arguments, the inconsistencies between Books I and II, and the repetitions in Book II of material from Book I, which I shall discuss below, make her position (in my view) unsustainable.
7. Mathiesen (1999) p. 297 ff.
8. "What we have said, then, shows clearly the way in which continuity and succession are to be sought: how they occur, and which interval is placed after which, and which is not, will be shown in our *Elements*." *Harmonics* 28.29–29.1.
9. In a similar way, Aristoxenus' criticism of the *harmonikoi* in Book I seems to have been drawn from an earlier work.
10. "The science concerned with melody has many parts and is divided into several species, of which the study called Harmonics must be considered one." *Harmonics* 1.11–16.

11. Cf. Barker (1989a) p. 126 n. 1. It should be noted that this inclusive use of the word *melos* would be unique in the *Harmonics*. Elsewhere it always refers to the 'melodic' element in music alone.
12. "Many other things are needed, as we are constantly saying, to make a man a musical expert. Harmonics is only a part of the musician's accomplishment, as are the sciences of rhythm, metre and instruments." *Harmonics* 32.4–9. Cf. Laloy (1904) p. 154 ff. There is also some similarity here to the presentation of the would-be musician in Plato: ἀνάγκη μὲν καὶ ταύτ' ἐπίσταςθαι τὸν μέλλοντα ἀρμονικὸν ἔσεσθαι, οὐδὲν μὴν κωλύει μηδὲ σμικρὸν ἀρμονίας ἐπαίειν τὸν τὴν σὴν ἔξιν ἔχοντα· τὰ γὰρ πρὸ ἀρμονίας ἀναγκαῖα μαθήματα ἐπίσταςθαι ἄλλ' οὐ τὰ ἀρμονικά. "It is true that one who proposes to become a master of harmony must know the things you speak of [how to produce the highest and lowest possible note on strings], but it is perfectly possible for one who has got as far as yourself to have not the slightest real knowledge of harmony. You are acquainted with what has to be learned before studying harmony, but of harmony itself you know nothing." *Phaedrus* 268e; trans. Hackforth (1952). Aristoxenus echoes Plato in suggesting that each clearly delineated aspect of musical research is essential to complete musical understanding, but also that it is insufficient on its own. This idea of an element that is essential but insufficient for complete understanding is used again by Aristoxenus at the end of Book II. Cf. Kucharski (1959) who notes (p. 70) the development in the *Phaedrus* of the notion of a divisive method of science.
13. Cf. Kucharski (1959), who notes the linguistic similarity to Plato in the *Philebus* 14c–19c.
14. "as we explain in detail how many parts there are in the science and what the function of each of them is" *Harmonics* 2.32–33.
15. περὶ μὲν οὖν ἐκείνων ἐν τοῖς καθήκουσι καιροῖς λεκτέον τίνες τ' εἰσὶ καὶ πόσαι καὶ ποία τις ἐκάστη αὐτῶν. "Concerning them we must say on the proper occasion what they are and how many there are, and what each is like." *Harmonics* 8.9–11.
16. Cf. Barker (1991a) p. 208 ff. on *dynamis* and its role in Books II and III of the *Harmonics* and how it relates to the perception of musical structures.
17. "But it is clear that none of these suggestions corresponds to the representations of sense perception: for perception assigns the names 'chromatic' and 'enharmonic' with an eye to the common feature of a single form, and not to the magnitude of a single interval. I mean that it assigns the form of the *pyknon* to every case in which the two intervals together cover a range smaller than the one, since in all *pykna*, though they are of different sizes, the sound of something compressed is evident to perception." *Harmonics* 48.22–31.
18. "But it is only in one sense that the magnitude is divisible through and through, viz. in so far as there is one point anywhere within it and all its

points are everywhere within it if you take them singly. But there are not more points than one anywhere within it, for the points are not consecutive; hence it is not divisible through and through." *On Generation and Corruption* 317a7–9; trans. Joachim (1922). Furthermore, the discussion on the potential and the actual in *Metaphysics* Book IX, and indeed throughout the Aristotelian corpus, and that on the soul in *De Anima*, adumbrate the Aristoxenian concept of the placement of the notes within musical space.

19. "For it must be understood that the *lichanoi* are unlimited in number. Wherever you arrest the voice in the range that accommodates the *lichanos* will be a *lichanos*, and no place in the *lichanos* range is empty or incapable of receiving a *lichanos*." *Harmonics* 26.14–18.
20. The terms *συνεχές* and *ἑξῆς* along with *ᾠπτεσθαι* and *ἐχόμενον* are discussed by Aristotle *Physics* 226b19–227b3 and *Metaphysics* 1068b26–1069a14. For the latter passage cf. Ross' commentary (1924) p. 344–5. On both passages and the concepts of continuity and succession in Aristoxenus cf. Bélis (1986) p. 153 ff.
21. *Harmonics* 28.18–24.
22. "Through hearing we assess the magnitudes of intervals, and through reason we apprehend their functions." *Harmonics* 33.7–9. Although the word *dynamis* does appear in the first book (1.18, 2.34, 19.9, 21.16), this is the first instance in which it is given a technical musicological sense. If the received text is correct, *dynamis* are here attributed to intervals, rather than to notes as usually elsewhere in the *Harmonics*. But we should probably look for ways of understanding this apparent anomaly, rather than eliminating it, as Macran does, by emending the text.
23. "The third part of the science as a whole must be that which deals with notes, and explains how many there are, by what means they are recognised, whether they are pitches, as most people suppose, or functions, and also just what a function is." *Harmonics* 36.6–12.
24. While many scholars have, of course, noted the repetitions between Books I and II, not many have concluded that the second book is a revision of the first.
25. ὅτι μὲν οὖν αἱ τῶν κινεῖσθαι πεφυκότων φθόγγων ἐπιτάσεις τε καὶ ἀνέσεις αἰτιαί εἰσι τῆς τῶν γενῶν διαφορᾶς φανερόν. "It is clear that it is the tensions and relaxations of the notes whose nature it is to move that are responsible for the differences between the genera." *Harmonics* 22.22–24.
26. Taking the definition of *systema* as more than one interval put together.
27. There is Cleonides' summary of Aristoxenus' treatment of composition in his *Introduction to Harmonics* (Ch. 14) and the passage in Aristides Quintilianus' *De Musica* (28.8–30.24) dependant on it. These two sources are unfortunately too cursory and their authors indulge in so little methodological discussion that their value is limited.

28. "With these definitions and preliminary distinctions behind us, we must now consider melody and try to outline what its nature is." *Harmonics* 18.5–7.
29. Bélis (1986) Chapter 3 describes three polemics which Aristoxenus carries out against the *harmonikoi* and then relates the technique of criticising predecessors to an Aristotelian method.
30. "It may be as well to explain in advance the kind of study this is, so that knowing beforehand the road, as it were, which we are to travel, and understanding which part of it we are on, we may walk the more easily, and not adopt unwittingly a misconception of the project." *Harmonics* 30.10–16.
31. Cf. Brancacci (1984) p. 173–5 on the temporal basis of musical perception in Aristoxenus and the dependence of the idea on Aristotle: cf. also Levin (1972) who argues that the value of Aristoxenus lies in his exploration of how the human mind comprehends musical experience.
32. "Each of these descriptions is to be understood with respect to the representation of perception. Whether it is actually possible or impossible for the voice to move and then to come to rest upon a single pitch, is a question belonging to a different enquiry, and for the purposes of the present science an account of [the motion involved in each of these] is unnecessary. For whatever the truth about that, it at any rate makes no difference to the way we distinguish melodic movement of the voice from movements of other kinds." *Harmonics* 9.2–12. The phrase τὸ δὲ κινῆσαι τούτων ἑκάτερον is probably corrupt cf. Macran p. 232–233. Barker (1989a) p. 133 n. 38, disagrees with Macran on the meaning of the phrase.
33. *Harmonics* 12.1–7.
34. "We try to give these matters demonstration which conform to the appearances, not in the manner of our predecessors, some of whom used arguments quite extraneous to the subject, dismissing perception as inaccurate and inventing theoretical explanations, and saying that it is in ratios of numbers and relative speeds that the high and low come about. Their accounts are altogether extraneous, and totally in conflict with the appearances." *Harmonics* 32.18–28. Text is Macran, as the δέ which Da Rios has for the τέ between λόγους and τίνας ἀριθμῶν is impossible.
35. *Harmonics* 7.10–14.
36. Cf. particularly Aristides Quintilianus 30.1 ff. with the notes ad loc. in Barker (1989a).
37. *Harmonics* 31.23–28.
38. Κατὰ δὲ μελοποιίαν γίνεται μεταβολή, ὅταν ἐκ διασταλτικοῦ ἤθους εἰς συσταλτικὸν ἢ ἡσυχαστικόν, ἢ ἐξ ἡσυχαστικοῦ εἰς τι τῶν λοιπῶν ἢ μεταβολὴ γένηται. "Modulation by melodic composition takes place whenever there is a modulation from the *diastaltic* ethos to the *systaltic* or *hesychastic*, or from the *hesychastic* to any of the rest." Cleonides Ch. 13, 206.3–5; trans. Mathiesen (1998) p. 45–6. Cf. Solomon (1981).

39. Cf. Bélis (1986) p. 174–5 who notes that Aristoxenus' treatise is affected by concessions to his audience.
40. "Some of my hearers have already raised problems about succession: (i) what succession in general is; (ii) whether it comes about in only one way or in several; and (iii) whether both conjunct and disjunct tetrachords are equally successive." *Harmonics* 59.6–12.
41. ταραττειν δ' εἶωθεν ἐνίους καὶ ἐν τούτῳ τῷ προβλήματι πῶς τὰ πλεῖστα προστίθεται καὶ διὰ τί οὐχ ἀπλῶς δείκνυται, ὅτι ἐκ τοσούτων ἀσυνθέτων ἕκαστον τῶν γενῶν συνέστηκεν ὅσα ἔστιν ἐν τῷ διὰ πέντε. "Some people have often found difficulty with the question why, in this proposition, the words 'at the most' are added, and why it is not simply shown that each of the genera consists of as many incomposite [magnitudes], as there are in the fifth." *Harmonics* 62.19–23.
42. As outlined particularly in the *Posterior Analytics*.
43. *Metaphysics* 983a24 ff. and 1013a24 ff.; *Physics* 192b8 ff.; *Posterior Analytics* 94a20 ff.
44. The latter two causes perhaps would become relevant in a discussion of composition, unfortunately not preserved.
45. *Physics* 199b34–200b8. In particular: ἐν ὅσοις τὸ ἕνεκά του ἔστιν, οὐκ ἄνευ μὲν τῶν ἀναγκαίαν ἔχόντων τὴν φύσιν, οὐ μὲντοι γε διὰ ταῦτα ἀλλ' ἢ ὡς ὕλην. "The product cannot come to be without things which have a necessary nature, but it is not due to these (except as material)." *Physics* 200a8–10; trans. Hardie and Gay (1962).
46. *Harmonics* 10.12–13.30.
47. "the incidence of the voice on one pitch." *Harmonics* 15.17.
48. "for it is when the voice appears to rest at one pitch that there seems to be a note capable of being put into a position in a harmonically attuned melody." *Harmonics* 15.18–21; Macran (1902); trans. Barker (1989a). Macran's interpolation makes more sense of the text than Da Rios' <το> and is included in Barker's translation.
49. "that musical understanding involves the simultaneous grasp of one thing that remains constant and another that changes" *Harmonics* 33.29–30.
50. "As in other fields, a principle is something simple, but it is not the same thing in all areas: in weight it is the *mina*, in melody the *diesis*, and in other areas other things." *Posterior Analytics* 84b37–9; trans. Barker (1989a) p. 70.
51. The *diesis* is also the measure for the *harmonikoi*.
52. In this sense Aristoxenus differs from Aristotle not merely about the identity of the measure, but in his conception of what a 'measure' is, since the tone is not, like the *diesis* in earlier systems, the unit of which all other intervals are multiples.
53. "With these definitions and preliminary distinctions behind us, we must now consider melody, and try to outline what its nature is." *Harmonics*

- 18.5–7. Bélis (1986) p. 139 ff. demonstrates Aristoxenus' understanding of the natural and necessary arrangement of musical space.
54. "These, then, are the things that should be dealt with in an introduction to the science known as harmonics: but now that we are on the point of setting out on the study that deals with the elements, we must notice in advance the following points." *Harmonics* 43.25–30. What Aristoxenus means by the term "elements" it is difficult to say: it seems to be either principles (as in the remainder of this book) or theorems (as they appear in the third book). The appearance of the term in Book I (29.1) appears to refer to the type of theorems of which Book III is comprised, since it refers to the succession of particular intervals.
 55. Both Brancacci (1984) and Bélis (1986) p. 215 ff. provide useful structural lists of the axioms at the ends of the first and second books and of the theorems of Book III. Barker (1991a), in his analysis of the axiomatic sections of the *Harmonics*, examines the sometimes opaque motivation for the particular techniques of axiomatic reasoning which Aristoxenus employs.
 56. "but we must look for our evidence in the nature of melody, and try to concentrate on understanding which interval the voice naturally and melodically places after which." *Harmonics* 28.20–24.
 57. "succession is to be sought by reference to the nature of melody." *Harmonics* 53.2–3.
 58. "We must next give an account of the first and most indispensable of the conditions that bear upon the melodic combination of intervals" *Harmonics* 53.33–54.1.
 59. "While it is usual in dealing with geometrical diagrams to say 'let this be a straight line . . .'" *Harmonics* 33.10–12. This language is particularly prominent in the Ps.-Euclid *Sectio Canonis*. The difference between them is that the imperative is used to exemplify rather than to define. Compare "Ἐστω διάστημα τὸ βγ, καὶ ἔστω πολλαπλάσιος ὁ β τοῦ γ, καὶ γεγενῆσθω ὡς ὁ γ πρὸς τὸν β ὁ β πρὸς τὸν δ." "Let there be an interval BC, and let B be a multiple of C, and let B be to D as is C to B." Ps.-Euclid, Proposition 1, 150.4–7; trans. Barker (1989a), and ἀγωγὴ δ' ἔστω ἢ διὰ τῶν ἐξῆς φθόγγων. "Let consecution be movement through successive notes." *Harmonics* 30.3.
 60. λαμβανέτω 53.34 and ἔστω 54.9.
 61. Uses of the imperative mood in the principles: εἰρήσθω 50.14 (3c); ἔστω 21.27 (2d), 30.5 (Book I principle), 45.8 (2b), 54.9 (Principle I); καλείσθω 21.27 (2d); λαμβανέτω 53.34 (Principle I), λεγέσθω 24.12 and 50.17 (4a); ὑποκείσθω 23.25 (3b) 29.2, 29.6, 29.14, 29.23, 29.27, 29.30 (Book I principles).
 62. "Let it be called conjunction when two tetrachords . . ." *Harmonics* 58.17.
 63. Theorems viii (63.33), ix (64.11), xi (65.8), xiii (65.32), xiv (66.10), xxv (72.13).

64. "Two ditones will not be placed in succession. Suppose they are. Then . . ." *Harmonics* 63.33–64.1.
65. Cf. Barker (1991a) esp. p. 29.
66. "But one must not overlook the fact that the principle we have stated is not enough by itself to ensure that the construction of *systemata* out of intervals is melodic. It is quite possible that even though the notes form concords in the numerical relations specified, the *systemata* are unmelodically constructed; but if this condition is not fulfilled there is no help to be had from the others." *Harmonics* 54.11–18.
67. Cf. Winnington-Ingram (1932) who notes Aristoxenus' 'guilty conscience' (p. 199) about his fudging of intervals. See also Litchfield (1988) p. 61–5.
68. The perfect system is mentioned in the first book at 6.3, but only in passing as an example of *systema*, with the promise that it will be discussed later.
69. Brancacci (1984) also avoids this problem by analysing Books II and III as a series of sixteen definitions (of note, interval etc.), culminating in three principles (which I have called axioms) followed by the twenty-seven theorems of the final book.
70. *Posterior Analytics* 71b20–23; trans. Tredennick (1960).
71. Cf. Brancacci (1984) p. 159.
72. "Successive tetrachords are either conjunct or disjunct." *Harmonics* 58.14–5.
73. "An incomposite interval is one bounded by successive notes" *Harmonics* 60.10.
74. "the notes bounding the parts which make up this number are successive with one another" *Harmonics* 53.27–8.
75. Cf. Barker (1984b).
76. "Each of the notes bounding the tone is the lowest note of a *pyknon*." *Harmonics* 63.20–22.
77. Cf. Barker (1991a).
78. (xii) πυκνὸν μὲν οὖν πρὸς διτόνω καὶ ἐπὶ τὸ βαρὺ καὶ ἐπὶ τὸ ὀξύ τίθεται.
 "A *pyknon* is placed next to a ditone, both above it and below." *Harmonics* 65.25.
 (xiii) τόνος δὲ πρὸς διτόνω ἐπὶ τὸ ὀξύ μόνον τίθεται.
 "A tone is placed next to a ditone only above it." *Harmonics* 65.32.
 (xiv) τόνος δὲ πρὸς πυκνῷ ἐπὶ τὸ βαρὺ μόνον τίθεται.
 "A tone is placed next to a *pyknon* only below it." *Harmonics* 66.10.
79. (xvii) ἀπὸ δὲ τοῦ διτόνου δύο μὲν ἐπὶ τὸ ὀξύ, μία δ' ἐπὶ τὸ βαρὺ.
 "From the ditone there are two progressions upwards and one downwards." *Harmonics* 66.28.
 (xviii) ἀπὸ πυκνοῦ δ' ἐναντίως ἐπὶ μὲν τὸ βαρὺ δύο ὁδοί, ἐπὶ δὲ τὸ ὀξύ μία.
 "From a *pyknon*, conversely, there are two progressions downwards and one upwards." *Harmonics* 67.11.

(xix) ἀπὸ δὲ τόνου μία ἐφ' ἑκάτερα ὁδός, ἐπὶ μὲν τὸ βαρὺ ἐπὶ τὸ δίτονον, ἐπὶ δὲ τὸ ὀξύ ἐπὶ τὸ πυκνόν.

"From a tone there is one progression in each direction, to a ditone downwards and to a *pyknon* upwards." *Harmonics* 67.25.

80. Cf. the careful explanation at 68.2 ff. of the ways in which truths about the enharmonic are paralleled by facts about chromatic and diatonic.
81. "Everything in music must be specified and assigned to its position in the sciences in accordance with the respect in which it is determinate, and in so far as it is indeterminate it must be passed over. Now in respect of the magnitudes of intervals and the pitches of notes, the facts about melody seem to be in some way determinate and ordered." *Harmonics* 69.3–12.
82. "It is to be shown that two notes which differ in respect of their positions in a *pyknon* cannot melodically be placed on the same pitch." *Harmonics* 72.13.

NOTES TO CHAPTER FOUR

1. *Harmonics* 32.4–9.
2. This is demonstrated by Mathiesen (1985) p. 170 ff. in the discussion of extant musical works containing rhythmic notation. Mathiesen also argues that the more complex rhythmical composition of earlier examples is simplified in later accompaniments to the extent that the rhythm of later compositions could almost be reconstructed from the verse.
3. The word itself, ῥυθμός, originally referred to arrangement, condition, or structure and did not achieve its specialised musical meaning until the late fifth century. Cf. Renchan (1963) and Barker (1984) p. 225, n. 131. It is first attested in Archilochus: γίνωσκε δ' οἷος ῥυθμὸς ἀνθρώπους ἔχει, "know what sort of pattern governs mankind." Text 128 *IEG* West (1971); trans. Gerber (1999).
4. There are, however a few early theoretical discussions on rhythm, about whose contents we know little. Diogenes Laertius attests (IX 48) that Democritus wrote a treatise Περὶ ῥυθμῶν καὶ ἀρμονίης, but only its title is preserved. Plato notes in both of the *Hippias* dialogues that rhythms, *harmoniai* and letters are subjects for sophistic discussion (*Hippias Major* 285d; *Hippias Minor* 368d).
5. Lasus of Hermione, "by altering the rhythms for the movement of the dithyramb . . . transformed the music that existed before him." Ps.-Plutarch 1141c; trans. Barker (1984a). While it is possible that in his (sixth-century) treatise on music Lasus included some discussion of rhythm or metre, this is suggested only by a late source (Martianus Capella IX 936).
6. This is not to deny that rhythmic innovation was a feature of compositional practice from very early times. See e.g. 1135c ff. and 1140f ff. Ps.-Plutarch, and his comment at 1138b–c. On the "new" music see Anderson (1994) p. 126–134; Richter (1967), (1968); West (1992) p. 356–372.

7. Fr. 155 K.-A., Ps.-Plutarch 1141d-1142a.
8. "And now Timotheus with his eleven-struck metres and rhythms makes *kitharis* spring up anew." *Persae* PMG 791, 229–231; trans. Barker (1984a).
9. "In the old days *kithara* songs were not allowed to be performed as they are now, or to include modulations of *harmoniai* and rhythms" Ps.-Plutarch 1133b; trans. Barker (1984a).
10. "... and in the rhythms they continually assumed great licence—I mean men like Philoxenus, Timotheus and Telestes." *De compositione verborum* 132; trans. Usher (1985).
11. "And again, the music and the rhythm must follow the speech." *Republic* 398d; trans. Shorey (1930).
12. "For the diction of prose does not violate or even alter the quantities in any noun or verb, but keeps the syllables long or short as it has received them by nature. However, the arts of music and rhythm change them by shortening or lengthening them, so that they often pass in their opposites: the time-length is not regulated by the quantity of the syllables, but the quantity of the syllables by the time length." *De compositione verborum* 64; trans. Usher (1985).
13. "... and that the order of motion is called "rhythm," while the order of the voice (in which acute and grave tones are blended together) is termed "harmony," and to the combination of these two the name "choristry" is given," *Laws* 664c-665a; trans. Bury (1926).
14. ἔν τε ταῖς κινήσεσιν αὖ τοῦ σώματος ἕτερα τοιαῦτα ἐνόντα πάθη γιγνόμενα, ἃ δὴ δι' ἀριθμῶν μετρηθέντα δεῖν αὖ φασὶ ῥυθμούς καὶ μέτρα ἐπονομάζειν. "... and in the movements of the body they identified other, similar inherent features which, they say, we must measure by numbers, and call rhythms and measures." *Philebus* 17d; trans. Barker (1989a).
15. "... the poets rudely sunder rhythm and gesture from tune, putting tuneless words into metre, or leaving tune and rhythm without words, and using the bare sound of harp or [aulos], wherein it is almost impossible to understand what is intended by this wordless rhythm and harmony, or what noteworthy original it represents." *Laws* 669d-e; trans. Bury (1926). Bury inappropriately translates "flute" for aulos.
16. Plato uses rhythm and *harmonia* in opposition: *Timaeus* 47d; *Symposium* 187b; *Protagoras* 326b; *Hippias major* 285d; *Hippias minor* 368d; *Republic* 399e, 401d; *Laws* 665a, 802e. He distinguishes rhythm from music generally (τὰ περὶ τοὺς ῥυθμούς καὶ πᾶσαν μουσικὴν) in the *Laws* 798d and refers to rhythm along with *harmonia* and *logoi* in *Republic* 398d. He refers to rhythm alone in *Cratylus* 424c. Admittedly there are exceptions. At *Republic* 380c1–2, 393d8, 607d7, for example, he uses the term *metron* to identify the feature which poetry possesses and prose lacks; and at 601a8, *metron*, *rhythmos* and *harmonia* are listed as separate features of song.

17. "... since from this alone of the rhythms mentioned no definite metre arises, and therefore it is the least obtrusive of them" *Ars Rhetorica* 1409a8–9; trans. Roberts (1954).
18. The term ἔπη is somewhat confusing; it may just refer to the words of verse but it also carries associations with epic poetry. Del Grande (1948) states with certainty that ἔπη refers to the dactylic hexameter; however, Barker (1984a) p. 100 n. 5 suggests that it refers here to words as they appear in verse.
19. *Clouds* 651. There is considerable discussion about the nature of the *enoplion* rhythm. For present purposes it can be accepted as a warlike rhythm which perhaps is similar enough to the dactylic to cause confusion. Cf. Del Grande (1948), Pretagostini (1979), Barker (1984a) p. 134 n. 6., Gentili (1988b).
20. Cf. Del Grande (1948) p. 5.
21. "I believe I have heard him [Damon] obscurely speaking of a foot that he called the enoplios, a composite foot, and a dactyl and an heroic foot, which he arranged, I know not how, to be equal up and down in the interchange of long and short, and unless I am mistaken he used the term iambic, and there was another foot that he called the trochaic, and he added the quantities long and short." *Republic* 400b–c; trans. Shorey (1930).
22. Shorey's translation (above) happily uses "foot" through this passage, although he does note that in relation to the heroic an alternative translation would be "rhythm" in order to include spondees as well as dactyls.
23. Several scholars have compared these two passages including Del Grande (1948) who seeks in them evidence for our knowledge of Damon, and Gentili (1988b) p. 6–9.
24. "I want to know which of the measures you think is best, the triple measure or the quadruple measure." Aristophanes *Clouds* 641–2; trans. Barker (1984a).
25. Also in the *Republic*: ἐπόμενον γὰρ δὴ ταῖς ἀρμονίαις ἂν ἡμῖν εἴη τὸ περὶ ῥυθμούς, μὴ ποικίλους αὐτοὺς διώκειν μηδὲ παντοδαπὰς βάσεις, ἀλλὰ βίου ῥυθμούς ἰδεῖν κοσμίους τε καὶ ἀνδρείους τίνες εἰσὶν οὓς ἰδόντα τὸν πόδα τῷ τοιούτου λόγῳ ἀναγκάζειν ἔπασθαι καὶ τὸ μέλος, ἀλλὰ μὴ λόγον ποδί τε καὶ μέλει. "For upon harmonics would follow the consideration of rhythms: we must not pursue complexity nor great variety in the basic movements, but must observe what are the rhythms of a life that is orderly and brave, and after observing them require the foot and the air to conform to that kind of man's speech and not the speech to the foot and tune." *Republic* 399e–400a; trans. Shorey (1930).
26. Cf. Anderson (1966) p. 76 ff. and Wallace (1991) p. 44 ff. who question the proposition that Damon is the champion of the conservatism; on Damon on rhythm see also Klitos Ioannides (1985–6) p. 260–63 and Lasserre (1954) esp. p. 66 ff.
27. Pearson (1990) p. xxviii claims there to have been no change in rhythmic theory with new music, only a change in practice. Pöhlmann (1960) p. 36

sets out a three-fold practical process of rhythmic development leading up to the time of Aristoxenus' treatise.

28. Plato *Republic* 398d ff. *Timaeus* 36a-b; Aristotle *Politics* Book VIII, esp. Ch. 7 (1337a9 ff.).
29. These sources have been collected by Pearson (1990) in his edition of Aristoxenus' *Rhythmics* along with the fragment from *On the Primary Chronos* and POxy 9/2687.
30. While Aristides Quintilianus follows the basic outline of Aristoxenus' description of harmonic space he also includes Pythagorean ratios (10.17 ff.) with no explanation about the conceptual differences between the two approaches.
31. Grenfell and Hunt (1898); Rea (1968); Pearson (1990) p. 36 ff.
32. Cf. Pearson p. xxi, who notes the use in the *Rhythmics* and in POxy 9/2687 of the terms *rhythmopoiia*, *lexis*, *chronoi* and *schema*. The term *syzygy* does not appear in the fragment on rhythm but does appear in the *Harmonics* 34.18.
33. *Metaphysics* 1087b36 ff. Gentili (1988b) p. 13 notes that both Plato and Aristotle based their analysis of rhythm on the syllable or the foot, and that it was Aristoxenus who separated metrics and music by using the abstract unit of the *chrotos protos*.
34. 'As to how metre differs from rhythm, some say that they are related as part to the whole: they say that metre is a division of rhythm, in accordance with their derivation of 'metre' from 'merein' which means 'to divide.' According to others, the difference lies in their material. Everything that comes into being they say, is generated out of at least two dissimilar entities; and while rhythm has its being in arsis and thesis, that of metre lies in syllables and their dissimilarity." Aristides Quintilianus 45.20–26; trans. Barker (1989a).
35. There are six pages on the methods of those combining the study of rhythm and metre (31.3–38.14), compared with just over one page on the techniques of those who separate them (38.17–39.25). The latter technique does not seem to have support from any other evidence on rhythm.
36. Aristides Quintilianus (40.20) claims that this is a doctrine of the ancients. Later theorists such as Alypius (367.4) divided the science of music into these three disciplines, harmonics (ἁρμονική), rhythmics (ῥυθμική) and metrics (μετρική). Cassiodorus also makes this division, defining rhythmics as *quae requirit incursionem verborum, utrum bene sonus an male cohaereat*, "that which inquires whether words in combination sound well or badly together" and metrics as *quae mensuram diversorum metrorum probabili ratione cognoscit, ut verbi gratia heroicon, iambicon, heleiakon*, "that which by valid reasoning knows the measures of the various metres; for example the heroic, the iambic and the elegiac." *Institutiones divinarum et saecularium litterarum* V 5, 144.7–11; trans. McKinnon (1998). Isidore in his *Etymologies* follows both these definitions word for word. Choeroboscus (8th century CE), who comments on Hephaestion (2nd century CE), also differentiates rhythm and

metre. There is no mention of the rhythmic elements of music in Nicomachus, but Bacchius Geron claims that Nicomachus has defined rhythm as an orderly motion of *chronoi* (93) in his comments on rhythm at the end of his *Introduction to the Art of Music* (93–101). Martianus Capella makes use of Aristoxenus' as well as Aristides Quintilianus' treatises in his summary of rhythms (IX 966–995) and maintains the separation of the rhythm and the rhythmised substance. Like Aristides Quintilianus, Martianus Capella reiterates the opposition of masculine rhythm and feminine melody (IX 995).

37. On the notion that metre relates to rhythm as part to whole, cf. Aristotle *Poetics* I448b20–21.
38. "In the preceding passage we explained that there are many kinds of rhythm, what each of them is like, for what reasons they came to acquire the same name, and what it is that underlies each of them. Now we must speak specifically of the rhythm that is located in music." *Rhythmics* 1.
39. Aristotle immediately clarifies his meaning: *τούτων δὲ ὁ μὲν ῥυθμὸς σχῆμα ἐστὶν ἡ δὲ διαθιγὴ τάξις ἡ δὲ τροπὴ θέσις*: "and of these rhythm is shape, inter-contact is order, and turning is position." *Metaphysics* 985b16–17; trans. Ross (1910).
40. Admittedly, this would lead to a re-evaluation, on my part, to the relationship between the books of the harmonic treatise. If the elementary section on the movement of the voice were an integral (rather than a preliminary) part of the science of harmonics the treatise, with all its repetitions and contradictions would have to be viewed as a single work. However, as I argued in the previous chapter, the internal evidence of the *Harmonics* strongly supports the thesis that the second book is a revision of the first.
41. ". . . that it is to do with durations and the perception of them." *Rhythmics* 2.
42. In Aristoxenus the list is constructed with brief descriptions 35.1–38.28. The list in Aristides Quintilianus 7.10–12, is in a slightly different order: notes, intervals, *systemata*, genera, *tonoi*, modulation, melodic composition.
43. Furthermore, if my assumptions about the relationship between the first two books of the *Harmonics* are correct, then that treatise does not divide this material into two books, yet the fragment of the *Rhythmics* is labelled in the codices as Book II. This label may merely refer to the fact that the fragment clearly does not come from the beginning of a treatise because it refers to earlier material. Alternatively, it may indicate that Books I of the *Rhythmics* and the *Harmonics* were devoted to elementary material. In any case there is no irrefutable parallel to the organisation of the *Harmonics*.
44. The methods of modulation proposed by Aristides are related to the differences between feet as they appear also in Aristoxenus, e.g. modulation from a rational rhythm to an irrational one. Incidentally, Aristides Quintilianus does not treat the concept of *rhythmizomenon*, although he does note the

three materials on which rhythm operates: ῥυθμίζεται δὲ ἐν μουσικῇ κίνησις σώματος, μελωδία, λέξις. "Rhythm is imposed in music upon the movement of the body, upon melody, and upon diction" Aristides Quintilianus 31.21–22; trans. Barker (1989a). However, he makes no attempt to discuss the conceptual differentiation between rhythm and *rhythmizomenon*.

45. Cf. Rowell (1979) p. 68 ff. on the Aristotelian relationship of form and substance evidenced in the *Rhythmics*.
46. "For the same utterance, when disposed into durations that differ from one another, takes on differences of a sort that are equal to the differences in the nature of the rhythm themselves." *Rhythmics* 4.
47. Cf. Rea (1968), Pearson (1990) p. 36 ff.
48. "... when the division of the durations takes on an organisation of some determinate sort: for not every organisation of durations is rhythmical [well-rhythmed]." *Rhythmics* 7.
49. "The facts concerning the combining of letters and that of intervals are familiar us, that is, that in talking we do not combine the letters in every way, nor do we so combine the intervals in singing." *Rhythmics* 8.
50. Cf. Laloy (1904) p. 295–97.
51. "Among durations, let us give the name 'primary' to that which is capable of being divided by none of the *rhythmizomena*, 'two-unit' to that which is measured twice by the primary, 'three-unit' to that measured three times, 'four-unit' to that measured four times." *Rhythmics* 10.
52. "... but Aristoxenus says, No, the syllable is not a measure, because every measure is fixed in respect of length and fixed in relation to that which it measures." Psellus *Introduction to the Study of Rhythm* 1; trans. Pearson (1990). For a strong statement of the view that Psellus' reasoning reproduces that of Aristoxenus see Pearson (1990) p. 67.
53. "For instance, while the ratio remains constant—the ratio by reference to which the genera are distinguished—the magnitudes of the feet are altered by the character of the tempo, and while the magnitudes remain constant the feet become dissimilar: and the same magnitude can function either as a foot or as a conjunction of feet. It is clear that distinctions of division and of arrangement also depend on a fixed unit of magnitude. In general, while rhythmic composition employs many varied kinds of movement, the feet by reference to which we indicate rhythms have simple movements that are always the same." *Harmonics* 34.14–25.
54. "We must understand that the units that preserve the character of the foot are distinct from the division brought into being by the rhythmic composition." *Rhythmics* 19.
55. "It follows from what has already been said that if there are an infinite number of *agogai* possible for each rhythm, there will also be an infinite number of primary *chronoi*." Porphyry 78.23–24; trans. Pearson (1990).

56. "We are not constructing feet out of 'infinite' *chronoi*, but from *chronoi* limited and defined in respect of their length and number, their mutual commensurability and order." Porphyry 79.11–14; trans. Pearson (1990).
57. δεῖ δὲ καταμαθεῖν, ὅτι καὶ περὶ τῆς ἁρμονικῆς ἐπιστήμης ὁ αὐτὸς ἂν γένοιτο λόγος. "We must recognise that the same argument will apply to harmonic science." Porphyry 79.21–23; trans. Pearson (1990).
58. Aristides Quintilianus' discussion of *rhythmopoia* (40.8–25) focuses almost entirely on the parallels between *rhythmopoia* and *melopoia*. He notes that they both involve selection (of a type of rhythm/melody), use, and mixture, and mentions some ethical styles.
59. "That by which we indicate the rhythm, and make it known to perception, is a foot, either one foot or more than one." *Rhythmics* 16.
60. Justification for the textual emendation (accepted by Pearson) appears when Aristoxenus claims that διὰ τί δὲ οὐ γίνεται πλείω σημεῖα τῶν τεττάρων, οἷς ὁ πούς χρήται κατὰ τὴν αὐτοῦ δύναμιν, ὕστερον δειχθήσεται. "It will explained later why there do not occur more than four units which the foot uses in accordance with its own character." *Rhythmics* 18.
61. "... for the two-unit magnitude would have a foot whose articulation was completely crowded together." *Rhythmics* 31.
62. "There are three genera of feet that admit continuous rhythmic composition: the dactylic, the iambic and the paionic." *Rhythmics* 30. The *Harmonics* also has three genera, but this is probably a coincidence, unless Aristoxenus' exclusion of the epitritic (4:3) foot is deliberate in order to maintain this number.
63. Although Aristoxenus specifically states that the smallest foot is of three units, Aristides Quintilianus names two shorts (~~) as a *prokeleumatic* or pyrrhic foot of the dactylic genus (35.5–6).
64. "... when the same magnitude is divided into parts that are unequal either in both their number and their magnitudes, or in one or the other." *Rhythmics* 27.
65. This is the interpretation promoted by Pearson (1990) p. 63.
66. "A magnitude of time that is understood as rational in rhythm must therefore be, first, one of those that enter into the rhythmic composition, and secondly a rational part of the foot in which it is placed." *Rhythmics* 21.
67. E.g. two and a half 9:8 tones do not exactly equal a 4:3 fourth, epimoric intervals cannot be divided mathematically equally, yet Aristoxenus insists that the semitone is half a tone.
68. Aristides Quintilianus' description of a second method of rhythmic science (38.17–39.25) may be such a candidate.
69. "For one thing is understood as being rational in respect of the nature of rhythm, another only in respect of the ratios of numbers." *Rhythmics* 21. This may refer to the rejection of the 4:3 foot. The 4:3 ratio is, of course, important in Pythagorean harmonic theory as the ratio of the fourth.

70. “. . . just as we have seen in the nature of melody.” *Rhythmics* 13.
 71. See the introduction to Pearson (1991) for a defence of the contrary view.

NOTES TO CHAPTER FIVE

1. These were collected by Fritz Wehrli, *Aristoxenos (Die Schule des Aristoteles* Vol. II) 2nd ed. Basle (1967).
2. Fr. 1, Suda s.v. Ἀριστόξενοϛ. The number has no guarantee of accuracy, but at least it indicates extensive writings, a perception reflected in, and strengthened by, the contents of the fragments.
3. Cf. Lynch (1972) 83–86.
4. As we have noted in Chapter 2, Aristotle defines the cumulative nature of the investigation of truth in *Metaphysics* 993a30–b4. The historical overview in Book I of the *Metaphysics* provides an apt example of this aspect of his scholarship.
5. Fr. 80, Ps.-Plutarch *De Musica* 1136c; Fr. 82, *ibid.* 1136e; Fr. 89, Athenaeus XIV 619d.
6. Fr. 101, Athenaeus XIV 634e.
7. Fr. 100, *ibid.* XIV 634d.
8. Fr. 102, Ammonius *De adfinium vocabulorum differentia* 271 Nickau.
9. Fr. 100, Athenaeus XIV 634d.
10. Fr. 104, *Anecdota Graeca* Bekker I 101.17; Fr. 105, Harpocration s.v. κορδακισμός; Fr. 106, *Etymologicum Magnum* s.v. σίκιννις. The last of these references attributes the reference to the first book of the work, thereby implying the existence of more than one book.
11. Fr. 113, Ammonius *De adfinium vocabulorum differentia* 432 Nickau.
12. Fr. 90, Schol. Platon *Phaedo* 108d.
13. Fr. 93, Porphyry 125.24.
14. *Ibid.* 78.21.
15. *Ibid.* 78.17.
16. Fr. 109, Athenaeus XIV 631d.
17. Fr. 128, Porphyry 80.18.
18. Fr. 129, Athenaeus XIV 619c.
19. Fr. 91, *Harpocration* s.v. Μουσαῖος; Fr. 91 I *Anecdota Osanni* Montanari 56. The subject of this work is uncertain. The first of the fragments refers to the musician Mousaios, the second to the opening of the *Iliad*. Praxidamas, a musician of the fourth century, is referred to in the Suda s.v. χιάζειν. Cf. Wehrli p. 76–77 and Lasserre p. 161.
20. As noted by Weil and Reinach (1900) p. iv–vi.
21. On the sources of Lysias’ speech cf. Weil and Reinach (1900) p. vi; Lasserre (1954) p. 101–2.
22. Athenaeus XIV 624c: Ἡρακλείδης δ’ ὁ Ποντικὸς ἐν τρίτῳ περὶ Μουσικῆς οὐδ’ ἁρμονίαν φησὶ δεῖν καλεῖσθαι τὴν Φρύγιον, καθάπερ οὐδὲ τὴν Λύδιον. ἁρμονίας γὰρ εἶναι τρεῖς· τρία γὰρ καὶ γενέσθαι

- Ἑλλήνων γένη, Δωριεῖς, Αἰολεῖς, Ἴωνας. "But Heraclides of Pontus, in the third book of his *On Music*, says that Phrygian should not even be called a *harmonia*, and no more should Lydian. There are, he says, three *harmoniai*, since there are three races of Greeks: Dorians, Aeolians and Ionians." trans. Barker (1984a). Cf. Weil and Reinach (1900) p. viii ff. and Barker (1984a) p. 213 n. 62. Aristoxenus' tendency towards the view that the three standard modes are Dorian, Phrygian and Lydian, is confirmed in the nomenclature he uses for his group of thirteen *harmoniai* cited by Cleonides (Ch. 12, 203.4–204.9).
23. Cf. Lasserre (1954) p. 102–4.
 24. Proclus *In Platonis Timaeum* III 192a, Diehl. This includes Wehrli's Fr. 8.
 25. Fr. 73, Philodemus *De Musica*, *PHerc.* 225/25.
 26. Fr. 74, Plutarch *Quaestiones Convivales* VII 704e.
 27. Porphyry 78.17.
 28. Fr. 80, Ps.-Plutarch 1136c; Fr. 82 *ibid.* 1136f. I have used the Latin *De Musica* to refer to Ps. Plutarch's work and the Greek *Peri Mousikes* to refer to Aristoxenus'.
 29. Fr. 89, Athenaeus XIV 619d.
 30. "Aristoxenus, in the first book of his work *On Music*, says that Olympus was the first to use Lydian, when he played a lament for the Python on the *aulos*." Fr. 80, Ps.-Plutarch 1136c; trans. Barker (1984a).
 31. *Republic* 398d–e. Cf. Anderson (1966) Ch. III on Plato's understanding of the role of music in society and on this passage esp. p. 72–3.
 32. "Aristoxenus says that it was Sappho who originally invented the Mixolydian, and that the composers of tragedies learned it from her. That is, they adopted this *harmonia* and linked it with the Dorian, since the latter expresses magnificence and dignity, and the former emotion; and tragedy is a blend of both." Fr. 81, Ps.-Plutarch 1136c–d; trans. Barker (1984a).
 33. "Since one of these *harmoniai* [the Mixolydian and the Lydian] is mournful and the other dissipated, it was only to be expected that Plato would reject them, and select Dorian as being appropriate for warlike and temperate men. This was most certainly not, as Aristoxenus claims in the second book of his work *On Music*, because Plato was ignorant of the fact that the other two *harmoniai* can also be of use to a well-ordered state." Fr. 82, Ps.-Plutarch 1136e–f; trans. Barker (1984a).
 34. See for instance *Harmonics* 30.17 ff. where he criticises Plato in comparison to Aristotle for not setting out in advance the subject matter of his lecture on the Good. More extremely, Diogenes Laertius reports that Aristoxenus is said to have claimed that Plato plagiarised the *Republic* (Fr. 67, Diogenes Laertius III 37), and that Plato wished to burn all the writings of Democritus (Fr. 131, Diogenes Laertius IX 40).
 35. ὁ δ' ἐν τῇ Πολιτείᾳ Σωκράτης οὐ καλῶς τὴν φρυγιστὶ μόνην καταλείπει μετὰ τῆς δωριστί, "But the Socrates of Plato's *Republic* is

- wrong to retain just the Phrygian along with the Dorian." Aristotle *Politics* 1342a32–4; trans. Barker (1984a). Cf. in general Bk. VIII, Ch. 7 of the *Politics*.
36. Wehrli (1967, p. 74) suggests that the citation of Aristoxenus stops at $\Phi\upsilon\lambda\alpha\kappa\iota\kappa\eta\eta\eta$ as does Lasserre (1954, p. 164) and that the following argument is from another source.
 37. Cf. *Harmonics* 23.4–12 and Fr. 124 in Athenaeus XIV 632b.
 38. It is unlikely, however, that Aristoxenus rooted his notions of ethos in the *harmoniai* or 'modes,' as Plato and Aristotle did, since he refers to them in the *Harmonics* only as structures discussed by his predecessors, and makes no use of them in his own analyses.
 39. "Aristoxenus, in Book IV of his *On Music*, says: 'In the old days the women sang a song called *Calyce*. It was Stesichorus' composition, in which a girl named Calyce, who loved the young Euathlus, prays modestly to Aphrodite that she may be married to him.'" Fr. 89, Athenaeus XIV 619d; trans. Barker (1984a).
 40. $\epsilon\upsilon\ \delta\epsilon\ \tau\omicron\iota\varsigma\ \kappa\alpha\tau\grave{\alpha}\ \beta\rho\alpha\chi\upsilon\ \Upsilon\pi\omicron\mu\eta\mu\alpha\sigma\iota\nu\ \delta\text{'}\ \text{Αριστοξένος}\ \text{"Ιφικλος, φησίν, Ἀρπαλύκην ἐρασθεῖσαν ὑπερεῖδεν. ἡ δὲ ἄπέθανεν καὶ γίνεται ἐπ' αὐτῇ παρθένους ἀγῶν ᾠδῆς, ἣτις Ἀρπαλύκη, φησί, καλεῖται."}$
 "In his *Summary Notes*, Aristoxenus says: 'Iphiclus rejected Harpalyce, who loved him. She died; and girls have a song-competition devoted to her, which is called *Harpalyce*.'" Fr. 129, Athenaeus XIV 619e; trans. Barker (1984a).
 41. "Olympus, so Aristoxenus says, is identified by the musical experts as the inventor of the enharmonic genus—all music before his time was diatonic or chromatic." Fr. 83, Ps.-Plutarch 1134f; trans. Barker (1984a).
 42. As observed by Wehrli (1967, p. 74).
 43. Lasserre (1954, p. 160–161) suggests either Glaucus of Rhegium (already cited 1132e, 1133f, 1134d) or Praxidamas "qui semble avoir été partisan du genre enharmonique et qui avait écrit une histoire des inventions musicales." (p. 161). He further argues that the language describing the invention refers to the lyre, not to the aulos, which implies a date when string based terminology only was in use and therefore the passage was written probably no earlier than the late fifth century. But this conclusion cannot be treated as secure.
 44. The final paragraph of Chapter 11 is a brief conclusion to the previous section, and includes a comment on the later division of the semitone in the enharmonic genus. Because of the change of tone involved it cannot automatically be considered as part of the material by Aristoxenus, although this possibility is by no means excluded.
 45. "Of these [genera] the diatonic, since human nature comes upon it first, must be reckoned the first and oldest, the chromatic second, and the enharmonic third and most sophisticated, since perception becomes accustomed to it at last, with difficulty, and through much hard work." *Harmonics* 19.22–29.

46. In Book I, 21.31–27.14. This theoretical discussion also appears in Book II, 46.20–52.31.
47. “The fact that there is a form of melodic composition which demands a ditone *lichanos*, and that far from being the most contemptible it is perhaps the finest, is not at all evident to most of those who are concerned with music nowadays, though it might become so if they were led towards it through a survey of examples. But what we have said is plain enough to those who are familiar with the first and second groups of ancient styles.” *Harmonics* 23.4–12. Barker (1989a) p. 141 points out that the reference to the superiority of the ditone interval and the “ancient styles” probably relates to the spondeion scale.
48. “This can readily be understood by anyone who listens to the *aulos* being played in the ancient style, where the semitone in the middle tetrachord is also meant to be incomposite.” Ps.-Plutarch 1135b (passed over by Werhli Fr. 83); trans. Barker (1984a).
49. 1135a. The “higher spondeiasmos” as Barker translates it. This refers either to the upper notes of the spondeion scale, or, as Barker thinks more likely, to the tense version of the spondeion. He discusses the probable meaning of this opaque section (1984a) p. 255–257. On the spondeion scale see Winnington-Ingram (1928).
50. *Harmonics* Book III, Theorem (viii) 63.33. The sequence in question is indeed faulty by the standards of the *Harmonics*, since it contravenes Axiom I. But its treatment in Ps.-Plutarch is surprising, since the theorem to which it refers deals only with a sequence of two incomposite ditones, whereas one of those involved in the spondeion (on any interpretation of the text) must be composite.
51. *Harmonics* 23.11–23. Cf. Barker (1989a) p. 141 n. 90 and (1984a) p. 216 n. 81, who surmises that Aristoxenus sees the ditone as the connection between the enharmonic genus and the spondeion structure of semitone and ditone, which fits any genus. Similar issues arise in another, closely related and equally Aristoxenian passage of Ps.-Plutarch, 1137a–d.
52. Wehrli (1967) p. 70.
53. Fr. 72, Quintilian *Institutio Oratoria* I 10.17. The reading is doubtful and many editors suggest Euenus in place of Aristoxenus.
54. Fr. 73, Philodemus *De Musica*, *PHerc.* 225/25.
55. Fr. 71a, Ps.-Acro *Scholia in Horatium* Sermon II 1.30 and Fr. 71b, Pomponius Porphyrio *Commentary on Horace* Sermon II 1.30.
56. Fr. 78, Athenaeus XIV 624b.
57. Fr. 79, *Vita Sophoclis* 23.
58. Fr. 100, Athenaeus XIV 634d.
59. Fr. 101, *ibid.* 634e.
60. Fr. 102, Ammonius *De adfinium vocabulorum differentia* 271 Nickau.
61. Fr. 104, *Anecdota Graeca* Bekker I 101.17; Fr. 105, Harpocration s.v. κορ-δακισμός; Fr. 106, *Etymologicum Magnum* s.v. σίκινυις.
62. Fr. 109, Athenaeus XIV 631d.

63. Fr. 112, *ibid.* I 22b.
64. Fr. 100, *ibid.* XIV 634d.
65. Fr. 113, Ammonius *De adfinium vocabulorum differentia* 432 Nickau.
66. Fr. 97, Athenaeus IV 182f.
67. Fr. 101, *ibid.* XIV 634e.
68. Fr. 102, Ammonius *De adfinium vocabulorum differentia* 271 Nickau.
69. Fr. 103, Athenaeus XIV 630d.
70. Fr. 108, *ibid.* XIV 631b.
71. Fr. 110, *ibid.* XIV 621c and Fr. 111, *ibid.* XIV 620e.
72. Dionysius of Halicarnassus *Demosthenes* 18. Cf. Leo (1901) p. 149–150.
73. Plato *Republic* 398c–400b.
74. Fr. 100, Athenaeus XIV 634d.
75. Fr. 96, *ibid.* IV 184d.
76. Fr. 135, *ibid.* I 19f–20a; Fr. 136, *ibid.* XIV 638b.
77. Fr. 115, *Vita Sophoclis* 1.
78. Fr. 114, Diogenes Laertius V 92.
79. Fr. 113, Ammonius *De adfinium vocabulorum differentia* 432 Nickau.
80. Fr. 98, Athenaeus XIV 635e; Fr. 99, *ibid.* XIV 635b.
81. Cf. Barker (1988a) and West (1997).
82. Fr. 100, Athenaeus XIV 634d.
83. Fr. 101, *ibid.* XIV 634e.
84. “Aristoxenus, however, judges instruments that are stringed and plucked to be better than wind instruments, saying that wind instruments are too easy; for many people—shepherds, for instance—play *auloi* and *syringes* without having been taught.” Fr. 95, Athenaeus IV 174e; trans. Barker (1984a). Barker translates *καθαπτᾶ* as “plucked” rather than “percussive” (as in the Gulick edition, 1950) with good reason since a percussion instrument is hardly going to require more skill than the aulos.
85. Fr. 97, Athenaeus IV 182f.
86. Fr. 97 I, Hesychius Lexicon s.v. *κλεψίαμβοι*.
87. Fr. 94, Philodemus *De Musica* IV 29.12 ff. Cf. Wilkinson (1938) p. 175, and Abert (1899) p. 27–37.
88. The interpretation of the passage as concerned with music’s moral and ethical value is debatable. The word *ethos* does not always carry ‘moral’ implications in musical contexts (cf. e.g. Aristoxenus *Harmonics* 48.32, *P.Oxy* 2687 col. 4 line 8, Ptolemy *Harmonics* 32.15, 39.13, 44.6, where its sense seems to be purely aesthetic, unconnected with music’s effects on the hearer’s moral dispositions). But the issues are too intricate to be examined here, and I shall proceed on the assumption (strongly indicated by some of the comments in Ps.-Plutarch) that an ethical interpretation is justifiable.
89. On *ethos* see Abert (1899) and Anderson (1966).
90. Iamblichus’ *De Vita Pythagorae* eg. 248 ff. (Fr. 18). Cf. De Vogel (1966) 162–166.

91. Fr. 26, *Anecdota Paris* I 172 Cramer.
92. Fr. 121, Martianus Capella IX 923–924.
93. “For when the musicians give instruction in singing, in lyre-playing, or in aulos-playing, they pretend to this virtue, for they say that these studies improve the character. You may hear this said not only by the Pythagoreans, but Aristoxenus also declares the same thing.” Fr. 123, Strabo *Geography* I 2, 3; trans. based on Jones (1917).
94. “For a change to a new type of music is something to beware of as a hazard to all our fortunes. For the modes of music are never disturbed without unsettling of the most fundamental political and social conventions, as Damon affirms and as I am convinced.” *Republic* 424c; trans. Shorey (1930).
95. Fr. 70, Themistius *Orationes* XXXIII beginning.
96. “In the same way, [Aristoxenus] says, now that the theatres have been utterly barbarised, and this vulgar music has advanced into the extremity of corruption, we too, few as we are, come together by ourselves and remember what music used to be like.” Fr. 124, Athenaeus XIV 632b; trans. Barker (1984a).
97. Ps.-Plutarch I 141d–142a = Fr. 155, K.-A.
98. There is a clear parallel between Aristoxenus’ statement that Olympus “thus became founder of the Hellenic and lofty style [of music],” καὶ ἀρχηγὸς γενέσθαι τῆς Ἑλληνικῆς καὶ καλῆς μουσικῆς (1135b), and the present passage’s description: Olympus “who is credited with having initiated Greek and nomic music,” ὃ δὲ τὴν ἀρχὴν τῆς Ἑλληνικῆς τε καὶ νομικῆς μουσικῆς ἀποδιδοῶσιν (1141b) trans. De Lacy (1936).
99. Weil and Reinach (xxii–xxiii) suggest the attribution although they admit one cannot be certain on the matter. They also cite as evidence the lack of terminological contradiction among sections attributed to Aristoxenus and the general conservative tone. Wehrli (p. 71) also cites the conservative tone as evidence of Aristoxenus’ authorship as well as the connection of this passage to the treatise on education which follows.
100. The fact that Aristoxenus is explicitly reintroduced as an authority at the beginning of Chapter 31 also suggests that some, at least, of the preceding material is not derived from him.
101. “From all this it is clear that music is capable of creating a particular quality of character in the soul, and if it can do that, it is plain that it should be made use of, and that the young should be educated in it.” *Politics* 1340b10–13; trans. Barker (1984a).
102. Cleonides Ch. 13, 206.3–18; Aristides Quintilianus 30.12–17. Cf. Solomon (1981).
103. “. . . for the characters that flow upon the higher notes are different from those that flow upon the lower ones, and those that flow upon the *parhypatoeideis* are different from those that flow upon the *lichanoecides*.” Aristides Quintilianus 10.13–15; trans. Barker (1989a).

104. Aristides Quintilianus 77.17–82.3. This section also includes Aristides' proposal for solmisation based on tau followed by masculine, feminine and neuter vowels. It should be noted, however, that neither of the last two passages cited comes from a part of Aristides' text in which Aristoxenian influence is detectable.
105. This has plausibly been argued by Barker (1984a p. 239 n. 211) and Thorp (1991).
106. "The enharmonic scale belongs very well to the Dorian harmonia, and the diatonic scale to the Phrygian, as Aristoxenus says." Fr. 84, Clement *Stromateis* VI 11, 88.1.
107. Brancacci (1988) p. 78–84 argues convincingly for Alcidas as the author. See also Anderson (1966) Ch. 5; Barker (1984a) p. 183–5; Cronert (1909); Rispoli (1991); West (1992) p. 246–253.
108. "For who does not know that the Aetolians and Dolopes and all those [who sacrifice, with West's reconstruction] at Thermopylae, though they always employ diatonic music, are braver than singers in tragedy, who have [always] been accustomed to singing in the enharmonic? Hence the chromatic does not make people cowardly, nor does the enharmonic make them brave." *Hibeh Papyrus* 13; 17–22; text West (1992a) p. 16; trans. Barker (1984a).
109. Diogenes Laertius X 31–32.
110. Fr. 73, Philodemus *De Musica* PHerc. 225/25. Cf. Wilkinson (1938). The second century AD sceptic Sextus Empiricus also attacks the value of music on several levels, including its ethical and educational worth in his work *Adversus Mathematicos*.
111. "It is made clear by Aristoxenus that correct or distorted practice has its source in training and teaching." Fr. 76, Ps.-Plutarch 1142b; trans. Barker (1984a).
112. "They used to pick out just one *tropos*, or a very small number, which they believed to be suited to the proper formation of character, and practised that sort of music alone." Ps.-Plutarch 1142c–f; trans. Barker (1984a).
113. "Two kinds of knowledge at least are thus necessary for anyone who is to distinguish the appropriate from the inappropriate. First, he must know the moral character which the construction seeks to produce, and secondly he must know the elements from which the construction is put together." Ps.-Plutarch 1143d; trans. Barker (1984a).
114. "For [the Muses] would never blunder so far as to assign a feminine tune and gesture to verses composed for men, or to fit the rhythms of captives and slaves to a tune and gestures framed for free men." *Laws* 669c; trans. Bury (1926).
115. The story comes from Aristotle (*Politics* 1342b9–11) who described how Philoxenus attempted to compose a dithyramb in the Dorian mode, but finds that he can only compose it in the Phrygian mode, for this is the appropriate mode for the dithyramb.

116. "It is clear that the sound of a *systema* is different from that of a composition constructed within that *systema*, and the study of the latter is not within the scope of the science of Harmonics." Ps.-Plutarch 1143a; trans. Barker (1984a). This passage may indicate the date of the educational treatise in relation to the *Harmonics*. As Book II of the *Harmonics* clearly includes composition as part of the science, while Book I excludes it, this part of the educational treatise most likely was written before Aristoxenus revised Book I. However, as Aristoxenus' discussion of composition does not survive, it is difficult to tell whether he considered the issue of propriety part of its study. In that case the relative dates are indiscernible.
117. "The worthy Pythagoras rejected the practice of judging music by means of perception, saying that its excellence was to be grasped by the mind. Hence he used not to judge it on the basis of hearing, but on that of the *harmonia* of proportions. He also thought that it was enough to let the study of music come to an end with the octave." Ps.-Plutarch 1144f-1145a; trans. Barker (1984a).
118. Frs. 11–41 contain fragments from works on the life of Pythagoras, Pythagoreanism and Pythagorean sayings.
119. Cf. West (1992) p. 164–66.
120. The rejection of the enharmonic on this account is echoed in Aristides Quintilianus: ἀκριβέστερον δὲ τὸ ἐναρμόνιον· παρὰ γὰρ τοῖς ἐπιφανεστάτοις ἐν μουσικῇ τετύχηκε παραδοχῆς, τοῖς δὲ πολλοῖς ἐστὶν ἀδύνατον· ὅθεν ἀπέγνωσαν τινες τὴν κατὰ δίεσιν μελωδίαν, διὰ τὴν αὐτῶν ἀσθένειαν καὶ παντελῶς ἀμελωδητον εἶναι τὸ διάστημα ὑπολαβόντες. "The enharmonic demands stricter precision, being accepted by the most outstanding musicians, while for most people it is impossible. Hence some people refuse to recognise the melodic form which proceeds by *dieses*, supposing, because of their own incapacity, that this interval is not capable of being melodically performed at all." Aristides Quintilianus 16.13–18; trans. Barker (1989a).
121. ἔτι δ' αὐτῶν ἃ μὲν ἐστὶν ἄρτια, ἃ δὲ περισσά, ἄρτια μὲν τὰ εἰς ἴσα διαιρούμενα, ὥς ἡμιτόνιον καὶ τόνος, περισσά δὲ τὰ εἰς ἄνισα, ὥς αἱ γ' διέσεις καὶ ε' καὶ ζ'. "Further, some of them are even, others odd, the even being those which are divided into equal parts, like the semitone and the tone, the odd those which are divided into unequal parts, like the intervals of three, five and seven dieses." Aristides Quintilianus 11.14–17; trans. Barker (1989a).
122. "That which is understood as rational in respect of the ratios of numbers must be thought of as being like the twelfth part of a tone in matters to do with intervals, or any other such thing that is used in comparisons between intervals." *Rhythmics* 21.
123. "If someone has worked hard at the educational aspect of music, and receives suitable training in childhood, he will applaud and accept what is fine and

criticise its opposite in music and in everything else as well." Ps.-Plutarch 1146a-b; trans. Barker (1984a). It cannot be reckoned certain, however, that this passage, or the remainder of Chapters 40–41, are derived from Aristoxenus. The abrupt turn in direction at the beginning of Chapter 40 may indicate a change to a different source.

124. "The truth is that music was introduced [into the symposium] because it is able to counteract and mollify the inflammatory power of wine, as your own beloved Aristoxenus says somewhere: he said that music was introduced because while it is of the nature of wine to send reeling the bodies and minds of those who indulge in it to the full, music, through its own order and proportion, calms them and leads them into the contrary condition." Fr. 122, Ps.-Plutarch 1146f-1147a; trans. Barker (1989a).
125. Fr. 6, Apollonius *Historiae Mirabiles* 49 = Theophrastus Fr. 726a Fortenbaugh.
126. "Each of the systemata is placed and sung in some particular region of the voice; and although this makes no difference to the systema considered in itself, it makes not just a casual difference, but just about the greatest difference there is to the melody produced in it." *Harmonics* 7.10–14.
127. "These people have misunderstood what we said in our public lectures: 'What we are trying to do is to show for each kind of melodic composition and for music in general that such and such a type damages the character while such and such another improves it': and while misunderstanding that, they have altogether failed to hear our qualification 'in so far as music is capable of yielding such benefits.'" *Harmonics* 31.23–28.
128. Porphyry 78.21.
129. Ibid. 78.17.
130. Fr. 93, *ibid.* 125.24.
131. Ibid. 80.18.
132. Cf. Barker (1978a) and Wallace (1995).
133. "The fact that they were quite unsystematic in their work, even about the things they did happen to touch on, became clear in our earlier remarks, when we were investigating the opinions of the harmonicists." *Harmonics* 2.26–30.
134. *Harmonics* 2.8–25.
135. "Most of the harmonicists did not even realise that this is a subject to be considered, as became clear in our earlier work." *Harmonics* 5.5–9.
136. "Eratocles did attempt an enumeration in just one section of it, without demonstration; but we saw previously, when we were examining that matter in its own right, that what he said amounted to nothing, but was all false, and his perception of the phenomena was erroneous." *Harmonics* 6.13–19. Elsewhere in the *Harmonics* the expression *emprosthen* regularly refers to passages earlier in the *Harmonics* itself. It is possible, then, that Aristoxenus' previous discussion of Eratocles' view appeared in the same treatise that contained our surviving Book I.

137. In the second and third books of the *Harmonics* Aristoxenus refers back to his own earlier discussion on the subject.
138. "Let us not be disturbed by the opinions of those who reduce notes to movements, and who say quite generally that sound is movement, as though we should be obliged to say that it sometimes happens that movement does not move, but is stationary and at rest . . . We shall say, none the less, that the voice stands still when perception exhibits it to us not setting off towards the high or the low . . . If when it moves in what we call motion it is acquiring a difference in speed in the motion of which these people speak, and if when being at rest in what we call rest its speed remains constant and retains one and the same pace, that need make no difference to us." *Harmonics* 12.4–29.
139. Archytas Fr. 1: ὅτι μὲν δὴ τοὶ ὀξεῖς φθόγγοι τάχιον κινέονται, οἱ δὲ βαρεῖς βράδιον, φανερόν ἅμιν ἐκ πολλῶν γέγονεν. "The fact that high-pitched notes move more quickly and low-pitched ones more slowly has become clear to us from many pieces of evidence." Porphyry 57.26–27; trans. Barker (1989a).
140. "That is enough about this for the moment: it has been explicated more fully and clearly elsewhere." *Harmonics* 12.32–33.
141. Fr. 90, Schol. Plat. *Phaedo* 108d.
142. Porphyry 78.17.
143. Fr. 93, *ibid.* 125.24. The fact that Porphyry refers to a *Peri melopoias* in at least four books makes it unlikely that the work in question was merely a section of the *Harmonics*.
144. Fr. 128, *ibid.* 80.18.
145. Fr. 69a, Cicero *De oratore* III 33.132; Fr. 69b, Cicero *De finibus* V 19.50; Fr. 69c, Vitruvius *De architectura* I 1.13; Fr. 69d, Aelian *De natura animalium* II 11; Fr. 69e, Alexander of Aphrodisias, *Commentary on Aristotle's Topics* 105a34; Fr. 69f, Martianus Capella II 212.
146. Fr. 11b, Clement *Stromateis* I 14, 62.2; Fr. 25, Gellius *Noctes Atticae* IV 11.
147. Fr. 50, Athenaeus XII 545a ff.
148. Fr. 34, Stobaeus *Eclogai* IV 25.45; Fr. 35, *ibid.* IV 1.49; Fr. 36, *ibid.* II 31.119; Fr. 37, *ibid.* III 10.66; Fr. 39, *ibid.* IV 37.4; Fr. 40, *ibid.* III 1.101; Fr. 41, *ibid.* I 6.18.
149. Fr. 31, Iamblichus *De Vita Pythagorae* 233.
150. Fr. 14, Diogenes Laertius I 118.
151. Παιδευτικοὶ νόμοι, Fr. 43, Diogenes Laertius VIII 15; Πολιτικοὶ νόμοι, Fr. 45, Athenaeus XIV 648d; Μαντινέων ἔθνη, Fr. 45, I, Philodemus *Peri Eusebias* 18, p. 85 Gomperz.
152. Fr. 23, Stobaeus *Eclogai* I Proem. 6.
153. Fr. 10a, Plutarch *Non posse suaviter vivi secundum Epicurum* X 1093b; Fr. 10b, Jerome *De viris illustribus* Praefatio.
154. Fr. 54a, Cyril *Contra Julianum* VI 185; Fr. 54b, Theodoretus *Graecarum affectionum curatio* XII 61; Fr. 60, Schol. Plat. *Apolog.* 18b.

155. Fr. 64, Eusebius *Preparation for the Gospel* XV 2; Fr. 66, Diogenes Laertius V 35.
156. Fr. 117, Apollonius *Historiae Mirabiles* 40.
157. Fr. 71a, Ps.-Acro *Scholium in Horatium* Serm. II 1.30; Fr. 71b Pomponius Porphyrio *Commentary on Horace Serm.* II 1.30
158. Fr. 76, Ps.-Plutarch 1142b.
159. Fr. 78, Athenaeus XIV 624b.
160. Fr. 86, Diogenes Laertius I 42.
161. Fr. 64, Eusebius *Preparation for the Gospel* XV 2.
162. Cf. on Archytas, Frs. 47–50; on Socrates Frs. 51–60.
163. Fr. 51, Cyril *Contra Julianum* VI 208.
164. Fr. 55, Plutarch *De Herodoti malignitate* IX 856c.
165. Fr. 54b, Theodoretus *Graecarum affectionum curatio* XII 61.
166. Fr. 7, Aelian *Varia Historia* VIII 13: λέγουσι δὲ καὶ Ἀριστόξενον τῷ γέλωτι ἀνὰ κράτος πολέμιον γενέσθαι.
167. Fr. 133, Aelian, *De natura animalium* VIII 7.
168. Fr. 134, Apollonius, *Historiae Mirabiles* 30.
169. Fr. 6, *ibid.* 49.

NOTES TO CHAPTER SIX

1. This is according to the labelling of Barker (1989a), Ch. 8 and Mathiesen (1975). Barbera (1991a) p. 151 notes that the propositions are actually only numbered up to eleven in most manuscripts. Jan's edition (1895) notes the absence of numbers after Proposition Eleven, and marks the subsequent sections with Arabic numerals.
2. A summary of the arguments concerning the authorship, date and original extent of the treatise is amply covered by Barbera's introduction to his (1991a) edition of the text.
3. Mathiesen (1975) p. 255 n. 34 notes a reconciliation between Pythagorean and Aristoxenian ideas in this treatise. Barker (1981b) p. 1 on the other hand sees the possibility of an 'oblique . . . confrontation' of Aristoxenian methods. Cf. also Barbera (1984c).
4. *Harmonics* 32.18–28.
5. Ps.-Euclid 148.6–149.11; trans. Barker (1989a).
6. Cf. Barker (1981b) p. 3. The term διάστημα—interval, prominent from the beginning of the treatise, does not necessarily connote a musical reference, it can be merely spatial as Mathiesen (1975) notes p. 254 n. 14.
7. Ps.-Euclid uses the ratios of the fourth, fifth, and octave, and the difference between the fourth, and fifth, the epogdoic tone defined by Philolaus. From Archytas, the treatise uses the proof that epimoric intervals cannot be divided equally.
8. Ptolemy 30.17–31.17.
9. "The parhypate and the trite do not divide the pyknon into equal intervals." Ps.-Euclid Proposition 18, 162.13–14.

10. Cf. Van de Waerden (1943) p. 169, Burkert (1972) p. 444–46, and Barbera (1991a) p. 58–60. All three note also the proof of the proposition depends on Proposition 8.8 of Euclid's *Elements*.
11. "In the case of an epimoric interval, no mean number, neither one nor more than one, will fall within it proportionally." Ps.-Euclid Proposition 3, 152.1–3. The connection of this proposition to Archytas is provided by Boethius' treatise III 11.
12. Although the enharmonic *pyknon* of the Pythagoreans is not epimoric (256:243) the proof can still be applied. If the *diesis* is placed between two tones, the resultant *systema* would span a fourth. As the fourth is epimoric it cannot be divided equally. Therefore the central interval of the fourth, the *diesis*, also cannot be divided equally.
13. Proposition 14: "The octave is less than six tones." Ps.-Euclid 160.20. This depends on Proposition 9: τὰ ἕξ ἐπόγδοα διαστήματα μείζονά ἐστι διαστήματος ἐνὸς διπλασίου. "Six epogdoic intervals are greater than one duple interval." 157.5–6.
14. Proposition 15: "The fourth is less than two and a half tones, and the fifth is less than three and a half tones." Ps.-Euclid 161.4–6.
15. The process Aristoxenus uses is discredited centuries later by Ptolemy (22.2–16), who clearly makes use of (at least) the knowledge contained in Ps.-Euclidean treatise; cf. Barbera (1991a) p. 27–8.
16. This may offer a clue as to the relative dating of the two treatises. The evidence suggests that the Ps.-Euclidean treatise, as a synthesis of earlier Pythagorean musical theory, was prompted by the appearance of Aristoxenus' empirical presentation of Greek musical systems. While Book I of the *Harmonics* was certainly written before the *Sectio Canonis* it is possible that Book II was written after it and that Aristoxenus' attempt to convince his readers of the size of the fourth is a response to the attack of the Pythagorean treatise against him. This hypothesis would have consequences for the dating of a different work. Since the author of the *Sectio Canonis* clearly knew Books 7–9 of Euclid's *Elements* (cf. propositions 2, 3, 9), the view that *Harmonics* Book II was written after the *Sectio Canonis* would commit us to assigning a relatively early date to *Elements* 7–9. On this issue see Barbera (1991a) p. 17, with the additional references cited there.
17. Proposition 16: "The tone will not be divided into two or more equal intervals." Ps.-Euclid 161.17–18.
18. With the exception of proposition 11, which involves a significant logical error.
19. *Metaphysics* 985b31–986a3.
20. Cf. Crocker (1966) and Barbera (1977).
21. Ptolemy 32.19–20.
22. Winnington-Ingram (1932) notes of the Pythagoreans and Aristoxenus: "But if they are under suspicion of letting irrelevant factors intrude into

- their calculations, he must equally be suspected of yielding to the attractions of symmetry and convenience." p. 195. Similarly, Barker (1978b) concludes of Aristoxenus: "Perhaps the influence of his reputedly Pythagorean upbringing, though he explicitly rejected all it stood for, made the Siren-song of Number in the end too seductive." p. 16.
23. Porphyry 61.22–65.15 = Theophrastus Fr. 716 Fortenbaugh; cf. Barker (1977) and Lippman (1964) p. 161.
 24. *Harmonics* 39.3–43.26.
 25. Cf. Barker (1989a) p. 209 ff. and Barker (1994a).
 26. "I especially, because of the restlessness and hurry of a traveller's life, am unable to devote myself with unruffled attention and mental concentration to the teaching of these matters, whose proper clarification demands above all both an opportune moment and careful reasoning, with leisure and without distraction." Nicomachus Ch. 1, 237.10–15; trans. Barker (1989a).
 27. Cf. Bower (1978).
 28. *Timaeus* 36a–b.
 29. Calcidius' fourth or fifth century commentary is summarised by Mathiesen (1999) p. 616–7.
 30. Cf. Barker (1994c) on Ptolemy's relationship with and understanding of the earlier Pythagoreans; Mathiesen (1999) p. 484–490 contains some discussion of the cosmological section of Ptolemy's treatise.
 31. Mathiesen discusses the issue of date in his (1983) edition of the treatise p. 10–14.
 32. On the sources of Boethius' treatise cf. Bower (1978).
 33. "Taken as a whole, our science is concerned with all musical melody. Its pursuit depends ultimately on two things, hearing and reason." *Harmonics* 33.3–6.
 34. "The science of music concerns melody and everything associated with melody." Aristides Quintilianus 4.18–19; trans. Barker (1989a).
 35. "It is thus a science, in which there is secure and infallible knowledge: for it will admit no change or alteration in the statements which it contains either in the role of propositions or in that of conclusions. At the same time we can reasonably call it a skill, since it is an organisation of perceptions, and of perceptions trained to accuracy." Aristides Quintilianus 4.24–5.2; trans. Barker (1989a).
 36. This aspiration to an axiomatic science is actually more appropriate to a Pythagorean method (and seen in the Euclidean *Sectio Canonis*), which can resort to acoustics to argue the consonance of epimoric and multiple intervals. Indeed, in the sixteenth century the breaking down of this absolute definition of consonance dependent on the supremacy of the first four numbers opened the possibility of more flexible notions of harmonics and allowed for a resurgence in Aristoxenian theory. Cf. Moyer (1992) Ch. 4 and Palisca (1961).
 37. "Harmonic knowledge is the power that grasps the distinctions related to high and low pitch in sounds: sound is a modification of air that has been struck

- (this is the first and most fundamental of things heard): and the criteria of *harmonia* are hearing and reason, not however in the same way." Ptolemy 3.1–4; trans. Barker (1989a). Boethius' treatise contains an abbreviated version of Porphyry's definition. *Armonica est facultas differentias acutorum et gravium sonorum sensu ac ratione perpendens*. "Harmonics is the faculty that weighs differences between high and low sound using the sense of hearing and reason." V 2, 352.4–5; trans. Bower (1989).
38. "For he says that music is not only a rational branch of learning, but it is perceptual and rational at the same time, and hence that it is necessary for the genuine student not to neglect either of the two, while putting what is evident to perception in the first place, since it is from there that reason must begin." Porphyry 28.9–12; trans. Barker (1989a).
 39. Porphyry 22.22–26.5.
 40. Cf. Barker (2000a) Chs. 10 and 11; West (1992) p. 240–242.
 41. The actual provenance of these scales has prompted considerable discussion including Mountford (1923); Winnington-Ingram (1936) p. 22–4; Potiron (1961). The debate is summarised in Anderson (1994) p. 154–58 though not to the satisfaction of Mathiesen (1999) p. 532–3 n. 92.
 42. "That the power of attunement is present in all things that are more perfect in their natures, but is revealed most fully through human souls and through the movements in the heavens." Ptolemy 94.21–23; trans. Barker (1989a).
 43. "Thus the enharmonic is to be compared to the natural and ethical, because of its decrease in magnitude by comparison with the others; the diatonic to the theological and the political, because of the similarity of its order and its majesty to theirs; and the chromatic to the mathematical and the domestic, because of the shared nature of what is intermediate in relation to the extremes." Ptolemy 98.17–21; trans. Barker (1989a).
 44. Ptolemy's references to the genera in these contexts need not, admittedly, be evidence of Aristoxenian influence, since he attributes distinctions between the genera also to the earlier, Pythagorean theorist Archytas. His ways of exploiting the number 12 may be more strongly indicative of his dependence on Aristoxenian ideas.
 45. μεταβολή δέ ἐστιν ἀλλοίωσις τοῦ ὑποκειμένου συστήματος καὶ τοῦ τῆς φωνῆς χαρακτήρος· "Modulation is an alteration of the underlying *systemata* and of the character of the sound." Aristides Quintilianus 22.11–12; trans. Barker (1989a). μελοποιία δὲ δύναμις κατασκευαστικὴ μέλους· "Melodic composition is the capacity for constructing melody." Aristides Quintilianus 28.10–11; trans. Barker (1989a).
 46. "For its progress across the space of the interval which it traverses, whether relaxing or increasing tension, must not be detected." *Harmonics* 10.15–17.
 47. "Continuous sound is that which makes its relaxations and tensions imperceptibly, because of their rapidity. Intervallic sound is that in which the pitches are clearly apparent, while what lies between them is imperceptible."

- Aristides Quintilianus 5.26–6.3; trans. Barker (1989a). Barker p. 404 ns. 24 and 25 notes the inconsistency between this passage and Aristoxenus' understanding of vocal movement.
48. Aristides could be taking up these ideas from Aristoxenus himself who, in his discussion of clearly Pythagorean methods, includes notions of sameness of movement even though he emphasises their irrelevance (*Harmonics* 12.10 ff.).
 49. "... being defined by the limits constituted by the even-toned sounds, and measured in relation to each other by the orderings of their differences." Ptolemy 10.16–18; trans. Barker (1989a).
 50. "But in actuality are limited in the same way as those of magnitude, that they have two boundaries, the one proper to the sounds themselves, the other to the hearing, and that the latter is greater than the former." Ptolemy 9.19–21; trans. Barker (1989a).
 51. This Aristoxenian idea also appears in Fr. 128 from the Σύμμικτα ὑπομνήματα, Porphyry 80.18.
 52. Levin has argued that Nicomachus' treatise is less about harmonic science and more about promoting Pythagorean theories, (1975) p. 46 ff., (1994) p. 42. Equally, Nicomachus could be using Aristoxenus as a source for his discussion which may account for the similarity in their discussions.
 53. "Every voice is either συνεχής which is continuous, or διαστηματική, which it is named when it is sustained by means of interval. A voice is continuous when, as in speaking reciting a prose oration, we hurry over words ... Διαστηματική, on the other hand, is that voice which we sustain in singing, wherein we submit less to words than to a sequence of intervals forming a tunc." Boethius I 12, 199.3–11; trans. Bower (1989). Bower's translation of *modulus* as "a sequence of intervals forming a tune" perhaps would be better translated "melody."
 54. Philolaus Fr. 6, Nicomachus Ch. 9, cf. Huffman (1993) p. 145 ff.
 55. Archytas Fr. 1, Porphyry 57.26–27.
 56. *Timaeus* 67b.
 57. *De Sensu* 448a9 ff.
 58. "A note is the incidence of the voice on one pitch" *Harmonics* 15.17.
 59. *Harmonics* 15.18–21.
 60. "In respect to pitch, notes are infinite; in respect to function, there are eighteen in each genus." Cleonides Ch. 2, 181.10–11; trans. Mathiesen (1998). Cf. *Harmonics* 69.3–12.
 61. "It is from the *mese* that the functions of the remaining notes are recognised, for how each of them functions becomes apparent in relation to *mese*." Cleonides Ch. 11, 202.3–5; trans. Mathiesen (1998). A further note about *dynamis* occurs at the end of the treatise but its authenticity is questionable and it appears to be an afterthought or a gloss.

62. "A note, then, is the smallest part of melodic sound." Aristides Quintilianus 7.15–16; trans. Barker (1989a).
63. "The functions of the notes are by nature unlimited in number, but those handed down to us, in each of the genera taken together, are twenty-eight." Aristides Quintilianus 7.16–18; trans. Barker (1989a).
64. "Intervals are put together in the following way. Two dieses are placed in succession, but not more: two semitones are placed in succession but not more: two tones are placed together, but not more; otherwise the total becomes discordant." Aristides Quintilianus 11.17–21; trans. Barker (1989a).
65. Actually, Bacchius' phrase τῶν μελωδουμένων "of the things that are put into melody" recalls Aristoxenus' distinction between ῥυθμός and τὰ ῥυθμιζόμενα in the *Rhythmics*.
66. "What is the first element of what concerns music? Note. This is the tensing of the voice to a single station in song. Every note has a sign, a name, and a function." Bacchius Geron 67, 306.18–20; Trans. Steinmayer (1985).
67. "First, about tones, which are the basic elements of my discipline. The tone has the same significance for us that the point has for geometers and the unit for arithmeticians." Martianus Capella IX 938–939; trans. Stahl, Johnson and Burge (1977).
68. Theon of Smyrna *Mathematics Useful for Reading Plato* 90.22–93.9.
69. "... not every sound nor every pitch of sound is called a note, but only that which is attuned, as for instance that of *mese* , *neate* and *hypate* . An interval, he says, is a specifically qualified relation that notes have to one another, such as the fourth, the fifth and the octave; and a *systema* is a specifically qualified container of intervals, such as the tetrachord, the pentachord and the octachord. A *harmonia* is an ordering of *systemata* , such as Lydian, Phrygian and Dorian." Theon of Smyrna 48.6–13; trans. Barker (1989a).
70. "The process of advancing in a continuous series and in a melodic way, however, does not occur either randomly or in just one unique manner, but according to certain determinate methods, in accordance with which the differences between what are called the 'genera' of melody are understood." Theon of Smyrna 52.11–17; trans. Barker (1989a).
71. ἐπεὶ δ' οὐ μόνον ἐκ διαστημάτων τε καὶ φθόγγων συνεστάναι δεῖ τὸ ἡρμοσμένον μέλος, ἀλλὰ προσδεῖται συνθέσεώς τινος ποιᾶς καὶ οὐ τῆς τυχεύσης. "But harmonically attuned melody must not only consist of intervals and notes: it demands also a way of putting them together which is of a special kind, and not haphazard." *Harmonics* 18.18–20.
72. As we have noted in an earlier chapter, Aristoxenus concludes Book I and II with a set of axioms which provide (however inadequately) proof for the theorems of Book III.
73. "A note is an indivisible sound, as it were a unit in respect of hearing: or, according to more recent writers, it is the incidence of sound on a single sim-

- ple pitch: or, as some say, it is a sound with no breadth, having no extension in space." Nicomachus Ch. 12, 261.4–8; trans. Barker (1989a).
74. "A note is a sound that retains one and the same tone." Ptolemy 10.19; trans. Barker (1989a).
 75. Bower translates: "Sound is a melodic instance of pitch; it is "melodic" in that it functions within a composition in a given tuning." I 8, 195.2–3. However, owing to the similarity of the citation by Porphyry (see following note) a less misleading translation is perhaps "A note therefore is the melodic (that is appropriate to melody) incidence of the voice on one pitch." *Sonus* meaning "note" or "tone" is used by Martianus Capella in his definition of the smallest part of musical sound cited above. Similarly the term *intensio* reflects the Greek term τᾶσις meaning "stretching" and, by extension, "tuning" or "pitch."
 76. "'A note is an incidence of melodic sound on one pitch.'" or "the melodic incidence of sound on one pitch.'" Porphyry 86.9–10. This is virtually the same as Aristoxenus' definition of note in Book I: φωνῆς πτωσις ἐπὶ μίαν τᾶσιν ὁ φθόγγος ἐστί. "A note is the incidence of the voice on one pitch." *Harmonics* 15.17.
 77. "At present we do not wish to define sound in general, but only that which is called "phthongos" in Greek, from the similarity to speaking, that is, φθέγγεσθαι. Interval is the distance of a high and low sound. Consonance is a mixture of high and low sound falling uniformly and pleasantly on the ears." Boethius I 8, 195.3–8; trans. Bower (1989).
 78. As we have seen, Nicomachus is happy to adopt Aristoxenian ideas and definitions without attributing them, cf. Bower (1978) on Nicomachus as a source for Boethius.
 79. "Having set forth these matters, it seems that we should discuss the number of genera within which all song is composed and which the discipline of harmonic theory contemplates." Boethius I 15, 200.23–25; trans. Bower (1989).
 80. The nearest Aristides comes to such an attempt is in the first two chapters of Book III.
 81. "Rational intervals are those whose magnitudes can be apportioned, such as the tone, semitone, ditone, tritone, and the like. Irrational intervals are those deviating from these magnitudes to a greater or lesser degree by some irrational magnitude." Cleonides Ch. 5, 189.4–8; trans. Mathiesen (1998).
 82. "Thus just as among intervallic elements, what is rational in respect of melody was understood as being that which, in the first place, is sung, and is, secondly, recognisable in magnitude, either in the way in which the concords and the tone are recognisable, or in the manner of those which are commensurate with these." *Rhythmics* 21.
 83. "Rational intervals are those of which it is possible to express the ratio (where by 'ratio' I mean the numerical relationship between one term and another),

irrational intervals those for which no ratio between the terms is found. Thus the ratio of the fourth is epitritic, that of the fifth is hemiolic, that of the octave is duple, and that of the tone is epogdoic." Aristides Quintilianus 11.5–9; trans. Barker (1989a).

84. "It might be supposed that our discussion is inconsistent, when we first set out our investigation of musical matters in terms of numbers, and then assert that the intervals are not capable of receiving these very same numbers precisely." Aristides Quintilianus 103.22–104.2; trans. Barker (1989a).
85. "It is therefore not implausible to suggest that music, like everything else, has its source in the nature of the universe, but that through its mixture with bodily matter it declines from its pinnacle of precision with respect to numbers: for in the regions above us it is accurate and incorruptible. Thus it is because we are impeded by the grossness of body that we are unable to divide intervals equally, and have *systemata* whose concords are defective." Aristides Quintilianus 105.18–25; trans. Barker (1989a).
86. "For it is demonstrated that the tone cannot possibly be divided into two equal parts, when conceived as being in epogdoic ratio, just as is the case for every other epimoric interval. For 9 is not capable of being divided into equal parts." Theon of Smyrna 53.15–19; trans. Barker (1989a).
87. Dividing an interval in half involves finding the square root of its ratio. In the ratio 9:8 the resulting square root is $3:\sqrt{8}$.
88. Cf. Barbera (1984a) p. 201 ff.
89. "Aristoxenus expresses the judgement that differences between sounds with respect to highness or lowness are qualitative. The Pythagoreans, on the other hand, hold that these differences are quantitative." Boethius V 4, 355.22–24; trans. Bower (1989).
90. "At present the diatonic genus is in greatest use." Martianus Capella IX, 957; trans. Stahl, Johnson and Burge (1977).
91. Cf. West (1992) p. 164–166.
92. "The use of the remaining two genera is in danger of being abandoned." Gaudentius 332.2–3.
93. These problems of interpretation are made all the more acute by the fact that Chapter 16 of Gaudentius is manifestly incomplete. Mathiesen helpfully reconstructs diagrams of Gaudentius' scale calculations in his translation (1998, p. 76–8).
94. Barbera (1977) gives some idea of the interrelationship of tetrachordal intervals across the genera, as well as between the tetrachords proposed by different theorists.
95. Theon of Smyrna *Mathematics Useful for Reading Plato* 90.22–93.9
96. Barker (1989a) p. 46–48.
 Archytas' Tetrachordal Divisions (Ptolemy 30.17–31.17):

Enharmonic	28:27	36:35	5:4
Chromatic	28:27	243:224	32:27

- | | | | | |
|--|----------|-------|-----|-----|
| | Diatonic | 28:27 | 8:7 | 9:8 |
|--|----------|-------|-----|-----|
97. Cf. Winnington-Ingram (1932).
98. Eratosthenes' Divisions (Ptolemy 70.10–74.3):
- | | | | | |
|--|------------|---------|-------|-------|
| | Enharmonic | 40:39 | 39:38 | 19:15 |
| | Chromatic | 20:19 | 19:18 | 6:5 |
| | Diatonic | 256:243 | 9:8 | 9:8 |
- 19:15 = 409 cents
 9:8 + 9:8 = 81:64 = ditone = 408 cents
 5:4 = major third = 387 cents
99. Didymus' tetrachordal divisions (Ptolemy 70.10–74.3):
- | | | | | |
|--|------------|-------|-------|-----|
| | Enharmonic | 32:31 | 31:30 | 5:4 |
| | Chromatic | 16:15 | 25:24 | 6:5 |
| | Diatonic | 16:15 | 10:9 | 9:8 |
100. Cf. Barker (1994a) p. 60 ff.
101. For "they spend most time and effort on the chromatic, whereas when they do occasionally come to the enharmonic they force it close to the chromatic, and the melody is correspondingly pulled out of shape." *Harmonics* 23.19–23.
102. Ptolemy's Tetrachordal Divisions (Ptolemy 33.1 ff.):
- | | | | | |
|--|------------------|---------|-------|------|
| | Enharmonic | 46:45 | 24:23 | 5:4 |
| | Soft Chromatic | 28:27 | 15:14 | 6:5 |
| | Tense Chromatic | 22:21 | 21:11 | 7:6 |
| | Soft Diatonic | 21:20 | 10:9 | 8:7 |
| | Tonic Diatonic | 28:27 | 8:7 | 9:8 |
| | Tense Diatonic | 16:15 | 9:8 | 10:9 |
| | Even Diatonic | 12:11 | 11:10 | 10:9 |
| | Ditonic Diatonic | 256:243 | 9:8 | 9:8 |
103. Cf. West (1992) p. 301–326.
104. Ptolemy himself does not ascribe any antiquity to the division. Winnington-Ingram (1928) suggests that the 12:11 interval indicates a familiarity with the "spondeion" interval of three *dieses*, and notes that "the account suggests that Ptolemy had invented it [the division] himself. It may, however, be a more or less conscious reflection of the Spondeion, which may not have become completely obsolete by then." (p. 90). Its symmetry could also suggest a desire for mathematical balance; further, Aristoxenus' mention of the Spondeion interval in the Ps.-Plutarch at 1135a ff. connects it very clearly with the enharmonic genus, not, as here with the diatonic. Finally, it indicates a break from the earlier Pythagorean musical tradition which did not attempt to go beyond the practical sphere, merely to describe it numerically, cf. Plato's complaint in the *Republic* 531b.
105. Boethius' Tetrachordal Divisions (Boethius IV 5–12):
- | | | | | |
|--|------------|---------|---------|-------|
| | Enharmonic | 512:499 | 499:486 | 81:64 |
| | Chromatic | 256:243 | 81:76 | 19:16 |

Diatonic 256:243 9:8 9:8
 (512:499 + 499: 486 = 256:243).

Boethius expresses his tetrachordal divisions not in this way, but using a tetrachord 3072:2304, which can express all the intervals of each genera.

106. Cf. Barbera (1977) p. 308 for a more detailed analysis of Boethius' arithmetic process.
107. "When we have demonstrated the way in which the incomposite intervals are put together with one another, we must discuss the *systemata* which are constructed out of them, the complete *systema* as well as others; and we must demonstrate from a consideration of them how many they are and what they are like, displaying both the differences between them in respect of magnitude and the differences displayed by each of the magnitudes in respect of arrangement, combination and position, so that none of the magnitudes, arrangements, combinations or positions involved in melodies may be left without demonstration." *Harmonics* 5.33–6.10.
108. The complicated history of modes in Greek theory has been much discussed: cf. e.g. Winnington-Ingram (1936); Gombosi (1951); Chailley (1956); Barbera (1984); Bower (1984); Solomon (1984); West (1992) p. 223 ff.
109. The source of these scales is uncertain but Barker (1989a) p. 419 n. 112 suggests that it came perhaps from a commentary on the *Republic*, or from an earlier work of Aristoxenus. They may ultimately go back to Damon, who is mentioned by Aristides in relation to *'harmoniai* 80.28–29.
110. "Sometimes they covered the span of a full octachord, and there are cases where they exceeded a six-tone *systema*. Often they fell short of it. Nor did they always include all the notes." Aristides Quintilianus 18.6–9; trans. Barker (1989a).
111. "First there is that in which the *pyknon* is at the bottom, secondly that in which a diesis lies on each side of the ditone, and thirdly that in which the *pyknon* lies above the ditone." *Harmonics* 74.19–21.
112. They are superfluous in the sense that they are merely repetitions at the octave of other *tonoi* in the system. Aristides Quintilianus (20.5–21.12) comments on the recent addition of two further *tonoi*.
113. Cassiodorus Institutiones V 8, 145.20 ff.; Alypius *Eisagoge Mousike* 368.17 ff.; Martianus Capella *De nuptiis Philologiae et Mercuri* 935.

Bibliography

- Abert, Hermann, "Die Stellung der Musik in der antiken Kultur" *Die Antike* 2 (1926) 136–54.
- Abert, Hermann, *Die Lehre vom Ethos in der griechischen Musik* Leipzig (1899) Repr. Tutzing (1968).
- Adler, Ada (ed.), *Suidae Lexicon* 5 Vols. Leipzig (1928–1938).
- Ahrens, Christin, "Volkmusik der Gegenwart als Erkenntnis für die Musik der Antike" *Die Musikforschung* 29 (1976) 37–45.
- Albrecht, Michael von, and Schubert, Werner, *Musik und Dichtung* Frankfurt am Maim (1990).
- Alexanderson, Bengt, *Textual Remarks on Ptolemy's Harmonics and Porphyry's Commentary* Göteborg (1969).
- Allan, D. J., *Aristotle: De Caelo* Oxford (1936).
- Anderson, Warren DeWitt, "The Importance of Damonian Theory in Plato's Thought" *Transactions of the American Philological Association* 86 (1955) 88–102.
- Anderson, Warren DeWitt, *Ethos and Education in Greek Music* Cambridge, Mass. (1966).
- Anderson, Warren DeWitt, "Word-Accent and Melody in Ancient Greek Musical Texts" *Journal of Music Theory* 17 (1973) 186–202.
- Anderson, Warren DeWitt, "What Song the Sirens Sang: Problems and Conjectures in Ancient Greek Music" *Research Chronicle of the Royal Musical Association* 15 (1979) 1–16.
- Anderson, Warren DeWitt, "Musical development in the School of Aristotle" *Research Chronicle of the Royal Musical Association* 16 (1980) 78–98.
- Anderson, Warren DeWitt, *Music and Musicians in Ancient Greece* Ithaca (1995).
- Archibald, R. C., "Mathematics and Music" *American Mathematical Monthly* 31 (1924) 1–25.
- Barbera, André, "Arithmetic and Geometric Divisions of the Tetrachord" *Journal of Music Theory* 21 (1977) 294–323.
- Barbera, André, "Interpreting an Arithmetical Error in Boethius's *De Institutione Musica* (iii 14–16)" *Archives internationales d'histoire des sciences* 31 (1981) 26–41.

- Barbera, André, "Republic 530C-531C: Another look at Plato and the Pythagoreans" *American Journal of Philology* 102 (1981) 395-410.
- Barbera, André, "The Consonant Eleventh and the Expansion of the Musical Tetractys: A Study of Ancient Pythagoreanism" *Journal of Music Theory* 28 (1984a) 191-223.
- Barbera, André, "Octave Species" *Journal of Musicology* 3 (1984b) 229-41.
- Barbera, André, "Placing *Sectio canonis* in Historical and Philosophical Contexts" *Journal of Hellenic Studies* 104 (1984c) 157-61.
- Barbera, André (ed.), *Music Theory and Its Sources: Antiquity and the Middle Ages* Notre Dame (1990).
- Barbera, André, *The Euclidean Division of the Canon: Greek and Latin Sources* Lincoln (1991a).
- Barbera, André, "New and Revived Approaches to Text Criticism in Early Music Theory" *Journal of Musicology* 9 (1991b) 57-73.
- Barbour, J. Murray, "The Persistence of the Pythagorean Tuning System" *Scripta Mathematica* 1 (1932) 286-304.
- Barbour, J. Murray, *Tuning and Temperament* East Lansing (1953).
- Barbour, J. Murray, "The Principles of Greek Notation" *Journal of the American Musicological Society* 13 (1960) 1-17.
- Barker, Andrew, "Music and Mathematics: Theophrastus against the Number-Theorists" *Proceedings of the Cambridge Philological Society* 23 (1977) 1-15.
- Barker, Andrew, "ΟΙ ΚΑΛΟΥΜΕΝΟΙ ἈΡΜΟΝΙΚΟΙ: The Predecessors of Aristoxenus" *Proceedings of the Cambridge Philological Society* 24 (1978a) 1-21.
- Barker, Andrew, "Music and Perception: a Study in Aristoxenus" *Journal of Hellenic Studies* 98 (1978b) 9-16.
- Barker, Andrew, "ΣΥΜΦΩΝΟΙ ἈΡΙΘΜΟΙ: A Note on Republic 531C1-4" *Classical Philology* 73 (1978c) 337-42.
- Barker, Andrew, "Aristotle on Perception and Ratios" *Phronesis* 26 (1981a) 248-66.
- Barker, Andrew, "Methods and Aims in the Euclidean *Sectio canonis*" *Journal of Hellenic Studies* 101 (1981b) 1-16.
- Barker, Andrew, "Aristides Quintilianus and Constructions in Early Music Theory" *Classical Quarterly* 32 (1982a) 184-97.
- Barker, Andrew, "Innovations of Lysander the Kitharist" *Classical Quarterly* 32 (1982b) 266-69.
- Barker, Andrew, *Greek Musical Writings* Vol. I Cambridge (1984a).
- Barker, Andrew, "Aristoxenus' Theorems and the Foundations of Harmonic Science" *Ancient Philosophy* 4 (1984b) 23-64.
- Barker, Andrew, "Theophrastus on Pitch and Melody" in *Theophrastus of Eresus* (ed. W. Fortenbaugh et al.) New Brunswick (1985) 560-583.
- Barker, Andrew, "Text and Sense at *Philebus* 56a" *Classical Quarterly* 37 (1987) 103-9.
- Barker, Andrew, "Che cos'era la "Mágadis"?" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988a) 96-107.

- Barker, Andrew, "Le Fonti della Antica Musica Greca" in *Lo Specchio della Musica: Iconographia musicale nella ceramica di Spina* (eds. F. Berti and D. Restani) Bologna (1988b) 9–17.
- Barker, Andrew, *Greek Musical Writings* Vol. II Cambridge (1989a).
- Barker, Andrew, "Archita di Taranto e l'armonica pitagorica" in *Tra Sicilia e Magna Grecia. Annali dell'istituto universitario orientale di Napoli* XI (1989b) 159–78.
- Barker, Andrew, "Aristoxenus' Harmonics and Aristotle's Theory of Science" in *Science and Philosophy in Classical Greece* (ed. A. Bowen) New York (1991a) 188–226.
- Barker, Andrew, "Reason and Perception in Ptolemy's *Harmonics*" in *Harmonia Mundi: Musica e filosofia nell'antichità* (ed. R. Wallace and B. MacLachlan) Rome (1991b) 104–130.
- Barker, Andrew, "Three Approaches to Canonic Division" *Apeiron* 24 (1991c) 49–83.
- Barker, Andrew, "Greek Musicologists in the Roman Empire" *Apeiron* 27 (1994a) 53–74.
- Barker, Andrew, "An Oxyrhynchus Fragment on Harmonic Theory" *Classical Quarterly* 44 (1994b) 75–84.
- Barker, Andrew, "Ptolemy's Pythagoreans, Archytas, and Plato's Conception of Mathematics" *Phronesis* 39 (1994c) 113–135.
- Barker, Andrew "Heterophonia and Poikilia: Accompaniments to Greek Melody" in *Mousike: Metrica, ritmica e musica greca in memoria di Giovanni Comotti* (ed. B. Gentili and R. Perusino) Pisa (1995) 41–60.
- Barker, Andrew, *Scientific Method in Ptolemy's 'Harmonics'* Cambridge (2000a).
- Barker, Andrew, "La musica di Stesicoro" *Quaderni Urbinati di Cultura Classica* 67 (2000b) 7–20.
- Barker, Andrew, "Early *Timaeus* Commentaries and Hellenistic Musicology" *Ancient approaches to Plato's 'Timaeus' BICS Supplement* 78 (2003) 73–87.
- Barnes, Jonathan, "Aristotle's Theory of Demonstration" *Phronesis* 14 (1969) p. 123–52.
- Barnes, Jonathan (ed.), *The Complete Works of Aristotle* Princeton (1984).
- Barnes, Jonathan, *Aristotle: Posterior Analytics* 2nd ed. Oxford (1994).
- Bassi, Domenico, "Frammenti inediti di opere de Filodemo (περὶ μουσικῆς, περὶ Θεῶν, περὶ ῥητορικῆς) in papiri Ercolanesi" *Rivista di filologia* 38 (1910) 321–56.
- Bataille, André, "Remarques sur les deux notations mélodiques de l'ancienne musique grecque" *Recherches de papyrologie* I (1961) 5–20.
- Baud-Bovy, Samuel, "Le dorien était-il un mode pentatonique?" *Revue de musicologie* 64 (1978) 153–80.
- Baud-Bovy, Samuel, "Chansons populaires de la Grèce antique" *Revue de musicologie* 69 (1983) 5–20; 70 (1984) 259–60.
- Baud-Bovy, Samuel, "La canzone popolare della grecia moderna e la musica antica" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 219–227.

- Beaton, Roderick, "Modes and Roads: Factors of Change and Continuity in Greek Musical Tradition" *The Annual of the British School at Athens* 75 (1980) 1–11.
- Becker, Heinz, "Syrinx bei Aristoxenos" in *Musa-Mens-Musici. Im Gedanken an Walther Vetter* (ed. H. Wegener) Leipzig (1969) 23–26.
- Becker, Oskar, "Frühgriechische Mathematik und Musiklehre" *Archiv für Musikwissenschaft* 14 (1957) 156–64.
- Bekker, Immanuel (ed.), *Anecdota Graeca* 3 Vols. Berlin (1814–1821).
- Bélis, Annie, "Les 'Nuances' dans le *Traité d'harmonique* d'Aristoxène de Tarente" *Revue des études grecques* 95 (1982) 54–73.
- Bélis, Annie, "Un nouveau document musical" *Revue des études grecques* 96 (1983) XX–XXI.
- Bélis, Annie, "Auloi grecs du Louvre" *Bulletin de correspondance hellénique* 108 (1984) 111–22.
- Bélis, Annie, "Un nouveau document musical" *Bulletin de correspondance hellénique* 108 (1984) 99–109.
- Bélis, Annie, "À propos de la construction de la lyre" *Bulletin de correspondance hellénique* 109 (1985) 201–20.
- Bélis, Annie, "La théorie de l'âme chez Aristoxène de Tarente" *Revue de philologie* 59 (1985) 239–46.
- Bélis, Annie, *Aristoxène de Tarente et Aristote: le Traité d'harmonique* Paris (1986).
- Bélis, Annie, "A proposito degli 'Inni delfici' ad Apollo" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 205–18.
- Bélis, Annie, "Les terms grecs et latins désignant des spécialités musicales" *Revue de Philologie* 62 (1988) 227–250.
- Bélis, Annie, "La trasmissione della musica nell'antichità" in *Lo Specchio della Musica: Iconographia musicale nella ceramica di Spina* (eds. F. Berti and D. Restani) Bologna (1988) 29–39.
- Bélis, Annie, "L'organologie des instruments de musique de l'antiquité: Chronique bibliographique" *Revue archéologique* (1989) 127–142.
- Bélis, Annie, *Les Musiciens dans l'Antiquité* Paris (1999).
- Berti, Fede (ed.), *Dionysos: Mito e mistero. Atti del convegno internazionale Comacchio 3–5 novembre 1989* Comacchio (1991).
- Berti, Fede, and Restani, Donatella (eds.), *Lo Specchio della Musica: Iconographia musicale nella ceramica di Spina* Bologna (1988).
- Beschi, Luigi, "La prospettiva mitica della musica greca" *Mélanges d'archéologie et d'histoire de l'École française de Rome* 103 (1991) 35–50.
- Besseler, H., and Schneider, M., *Musikgeschichte in Bildern* II/4 Griechenland (ed. M. Wegner) Leipzig (1963).
- Blume, Friedrich (ed.), *Gedenkschrift für Hermann Abert* Tutzing (1974).
- Bolton, Robert, "Definition and scientific method in Aristotle's *Posterior Analytics* and *Generation of Animals*" in *Philosophical Issues in Aristotle's Biology* Cambridge (1987) 120–166.

- Borthwick, Edward Kerr, "ΚΑΤΑΛΗΨΙΣ A Neglected Technical Term in Greek Music" *Classical Quarterly* 9 (1959) 23–9.
- Borthwick, Edward Kerr, "Some Problems in Musical Terminology" *Classical Quarterly* 17 (1967) 145–57.
- Borthwick, Edward Kerr, "Notes on the Plutarch *De Musica* and the *Cheiron* of Pherecrates" *Hermes* 96 (1968) 60–73.
- Borthwick, Edward Kerr, "'The Wise Man and the Bow' in Aristides Quintilianus" *Classical Quarterly* 41 (1991) 275–8.
- Bowen, Alan C., "The Minor Sixth (8:5) in Early Greek Harmonic Science" *American Journal of Philology* 99 (1978) 501–6.
- Bowen Alan C., "The Foundations of Early Pythagorean Harmonic Science: Archytas, Fragment 1" *Ancient Philosophy* 2 (1982) 79–104.
- Bowen, Alan C., "Menaechmus *versus* the Platonists: Two Theories of Science in the Early Academy" *Ancient Philosophy* 3 (1983) 12–29.
- Bowen, Alan C., "Euclid's *Sectio canonis* and the History of Pythagoreanism" in *Science and Philosophy in Classical Greece* (ed. A. Bowen) New York (1991) 164–87.
- Bower, Calvin M., "Boethius and Nicomachus: An Essay Concerning the Sources of *De institutione musica*" *Vivarium* 16 (1978) 1–45.
- Bower, Calvin M., "The Modes of Boethius" *Journal of Musicology* 3 (1984) 252–63.
- Bower, Calvin M., *Boethius: The Fundamentals of Music* New Haven (1989).
- Boyancé, Pierre, *Le culte des Muses chez les philosophes grecs* Paris (1937).
- Boyancé, Pierre, "Note sur la tétractys" *L'Antiquité classique* 20 (1951) 421–5.
- Boyancé, Pierre, "Note sur l'éther chez les Pythagoriciens, Platon et Aristote" *Revue des études grecques* 80 (1967) 202–9.
- Brancacci, Aldo, "Aristosseno e lo stato epistemologico della scienza armonica" in *La scienza ellenistica* (ed. G. Giannontoni and M. Vegetti) Naples (1984) 154–85.
- Brancacci, Aldo, "Alcidamante e PHibeh 13 'De Musica': Musica della retorica e retorica della musica" in *Aristoxenica, Menandrea, fragmenta philosophica* (ed. F. Adorna) Florence (1988) 61–84.
- Brandl, Rudolf and Konstantinou, Evangelos (eds.), *Griechische Musik und Europa* Symposium 9–11 May, 1986 *Orbis Musicarum* 3 (1988).
- Braun, Ludwig, "Adynata und versus intercalaris im Lied Damons (Vergil, Ecl. 8)" *Philologus* 113 (1969) 292–7.
- Bühler, Winfried, *Zenobii Aithoi proverbialia* Vol. V Gottingae (1999).
- Bulmer-Thomas, Ivor, "Plato's Astronomy" *Classical Quarterly* 34 (1984) 107–12.
- Burkett, Walter, "Hellenistische Pseudopythagorica" *Philologus* 105 (1961) 16–43 and 26–246.
- Burkert, Walter, *Weisheit und Wissenschaft: Studien zu Pythagoras, Philolaos und Platon* Nuremberg, (1962). Trans. E. L. Minar as *Love and Science in Ancient Pythagoreanism* Cambridge, Mass. (1972).
- Burnet, J., *The Complete Works of Plato* 5 Vols. Oxford (1900–1907).
- Bury, R. G., *Plato: Laws* 2 Vols. Cambridge, Mass. (1926).

- Bury, R. G., *Sextus Empiricus* 4 Vols. Cambridge, Mass. (1933–49).
- Bury, R. G., "Theory of Education in Plato's 'Laws'" *Revue des études grecques* 50 (1937) 304–320.
- Busse, Adolf, "Zur Musikästhetik des Aristotles" *Rheinisches Museum* 77 (1928) 34–50.
- Butler, H. E., *Quintilian* 2 Vols. Cambridge Mass. (1921–1922).
- Caldwell, John, "The *De Institutione Arithmetica* and the *De Institutione Musica*" in *Boethius: His Life, Thought and Influence* (ed. M. Gibson) Oxford (1981) 135–154.
- Cassio, A. C., "Nicomachus of Gerasa and the Dialect of Archytas, Fr. 1" *Classical Quarterly* 38 (1988) 135–9.
- Cassio, A. C., D. Musti, L. E. Rossi (eds.), *Synaulia: cultura musicale in Grecia e contatti mediterranei. Annali dell'Istituto Universitario Orientale di Napoli* 5 Naples (2000).
- Castaldo, Daniela, "Satiri Citaredi Ceramica Attica: Un Problema Aperto" Vecchia and Restani (eds.), *Trent'anni di Ricerca Musicologica: Studi in Onore di F. Alberto Gallo* Rome (1996) 363–380.
- Cazden, Norman, "Pythagoras and Aristoxenos Reconciled" *Journal of the American Musicological Society* 11 (1958) 97–105.
- Chadwick, Henry, *Boethius: The Consolations of Music, Logic, Theology, and Philosophy* Oxford (1981).
- Chailley, Jacques, "L'Hexatonique grec d'après Nicomaque" *Revue des études grecques* 69 (1956) 73–100.
- Chailley, Jacques, "Le mythe des modes grecs" *Acta musicologica* 28 (1956) 137–63.
- Chailley, Jacques, "La musique de la tragédie grecque devant une découverte épigraphique" *Revue de musicologie* 39 (1957) 6–9.
- Chailley, Jacques, "Nouvelle remarques sur les deux notations musicales grecques" *Recherches de papyrologie* 4 (1967) 201–16.
- Chailley, Jacques, "La notation archaïque grecque d'après Aristide Quintilien" *Revue des études grecques* 86 (1973) 17–34.
- Chailley, Jacques, *La musique grecque antique* Paris (1979).
- Chamberlain, David S., "Philosophy of Music in the 'Consolatio' of Boethius" *Speculum* 45 (1970) 80–97.
- Ciancaglini, Claudia A., "L'acustica in Archita" *Maia* 50 (1998) 213–51.
- Clements, Ernest, "The Interpretation of Greek Music" *Journal of Hellenic Studies* 42 (1922) 133–66; 56 (1936) 25–35.
- Coleman-Norton, Paul Robinson, "Cicero Musicus" *Journal of the American Musicological Society* 1 (1948) 3–22.
- Colson, F. H., *M. Fabii Quintiliani: Institutionis Oratoriae liber primus* Cambridge (1924).
- Comotti, Giovanni, "L'endecacordo di Ione di Chios" *Quaderni Urbinati di Cultura Classica* 13 (1972) 54–61.
- Comotti, Giovanni, "L'aulos *ghingras* in una scena menandrea del mosaico di Dioscuride" *Quaderni Urbinati di Cultura Classica* 20 (1975) 215–23.

- Comotti, Giovanni, "Words, Verse and Music in Euripides' *Iphigenia in Aulis*" *Museum Philologum Londinense* 2 (1977) 69–84.
- Comotti, Giovanni, "Atena e gli *aulòi* in un ditirambo di Teleste (fr. 805 P)" *Quaderni Urbinati di Cultura Classica* 5 (1980) 47–54.
- Comotti, Giovanni, "Un'antica arpa, la *mágadis* in un frammento di Teleste (fr. 808 P)" *Quaderni Urbinati di Cultura Classica* 15 (1983) 57–71.
- Comotti, Giovanni, "Il valore termine *ἑντασίς* in Ps. Plut. *De mus.* 28 a proposito dei ritmi de Archiloco" *Quaderni Urbinati di Cultura Classica* 14 (1983) 93–101.
- Comotti, Giovanni, "I problemi dei valori ritmici nell'interpretazione dei testi musicali della Grecia antica" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 17–25.
- Comotti, Giovanni, "Gli strumenti musicali nelle raffigurazioni delle ceramiche del Museo Archeologico Nazionale di Ferrara" in *Lo Specchio della Musica: Iconographia musicale nella ceramica di Spina* (eds. F. Berti and D. Restani) Bologna (1988) 41–54.
- Comotti, Giovanni, "L'anabolé e il ditirambo" *Quaderni Urbinati di Cultura Classica* 31 (1989) 107–17.
- Comotti, Giovanni, "Melodia e accento di parola nelle testimonianze degli antichi e nei testi con notazione musicale" *Quaderni Urbinati di Cultura Classica* 32 (1989) 91–108.
- Comotti, Giovanni, "La musica nella tragedia greca" in *Scena e spettacolo nell'antichità* (ed. Lia de Finis) Firenze (1989) 43–61.
- Comotti, Giovanni, *Music in Greek and Roman Culture* (Trans. Rosaria V. Munson) Baltimore (1989).
- Comotti, Giovanni, "Un'occasione perduta: la traduzione italiana del *De musico* dello Ps. Plutarco" *Quaderni Urbinati di Cultura Classica* 31 (1989) 131–137.
- Comotti, Giovanni, "Pitagora, Ippaso, Laso e il metodo sperimentale" in *Harmonia Mundi: Musica e filosofia nell'antichità* (ed. R. Wallace and B. MacLachlan) Rome (1991) 20–29.
- Comotti, Giovanni, "Il 'canto Lidio' in due frammenti di Teleste (frr. 806; 810P)" in *Tradizione e innovazione nella cultura-greca da Omero all'età ellenistica: Scritti in onore di B. Gentili* Vol. 2 (ed. R. Pretagostini) Rome (1993) 513–20.
- Cornford, F. M., *Plato's Cosmology: The Timaeus of Plato Translated with a Running Commentary* London and New York (1937).
- Cornford, F. M., *Plato and Parmenides* London (1939).
- Cornford, F. M., *Plato: Republic* Oxford (1951).
- Cramer, John Antony, *Anecdota Graeca e Codd. Manuscriptis Bibliothecae Regiae Parisiensis* Oxford (1839–41) Repr. Hildesheim (1967).
- Crocker, Richard L., "Musica Rhythmica and Musica Metrica in Antique and Medieval Theory" *Journal of Music Theory* 2 (1958) 2–23.
- Crocker, Richard L., "Pythagorean Mathematics and Music" *Journal of Aesthetics and Art Criticism* 22. 2 (1963) 189–98; 22. 3 (1964) 325–35.

- Crocker, Richard L., "Aristoxenus and Greek Mathematics" in *Aspects of Medieval and Renaissance Music: A Birthday Offering to Gustave Reese* (ed. Jan La Rue) New York (1966) 96–110.
- Crönert, Wilhelm, "Die Hibeheude über die Musik" *Hermes* 44 (1909) 503–21.
- Curtis, John, "Greek Music" *Journal of Hellenic Studies* 33 (1913) 35–47.
- Curtis, John, "Reconstruction of the Greater Perfect System" *Journal of Hellenic Studies* 44 (1924) 10–23.
- Czerny, Miroslav, "Zur Problematik der altgriechischen 'Tonarten'" *Eirene* 25 (1988) 87–103.
- Czerny, Miroslav, "Zur Entstehung und Deutung der altgriechischen Notenschrift" *Listy Filologicke* 113 (1990) 9–18.
- Da Rios, Rosetta, *Aristoxeni Elementa Harmonica* Rome (1954).
- Dechavanne, Yves, "L'Éducation musicale en Grèce des origins à Platon" *Archeologia: Trésors des âges* 56 (1973) 46–9.
- De Finis, Lia (ed.), *Scena e spettacolo nell'antichità* Atti del Convegno Internazionale di Studio (Trento 28–30 marzo 1988) Firenze (1989).
- Del Grande, Carlo, "Nomos citharodico" *Rivista Indo-Greca-Italica* 7 (1923) 1–17.
- Del Grande, Carlo, "Musica enarmonica nell'antica Grecia" *Rivista musicale italiana* 36 (1929) 533–47.
- Del Grande, Carlo, *Espressione musicale dei poeti greci* Naples (1932).
- Del Grande, Carlo, "Damone metrico" *Filologia minore* Milan, Naples (1956) 197–214 also in *Giornale italiano di filologia* 1 (1948) 3–16.
- Delattre, Daniel, "Philodème de la musique: Livre IV, colonnes 40* à 109*" *Cronache Ercolanesi* 19 (1989) 49–143.
- Deubner, Ludovicus and Udalricus Klein, *Iamblichi De Vita Pythagorica Liber* 2nd Ed. Stuttgart (1975).
- Denniston, John Dewar, "Some Recent Theories of the Greek Modes" *Classical Quarterly* 7 (1913) 83–99.
- De Falco, V., and Udalricus Klein, *[Iamblichi] Theologumena Arithmeticae* 2nd Ed. Stuttgart (1975).
- De Vogel C. J., *Aristotle, the Early Peripatetic School and the Early Academy* (Greek Philosophy: A Collection of Texts with Notes and Explanations Vol. 2) Leiden (1953).
- De Vogel, C. J., *Pythagoras and Early Pythagoreanism* Assen (1966).
- De Vries, G. J., "Aristoxenos über Περὶ τὰ γαθοῦ" *Hermes* 96 (1968) 124–6.
- Dick, A. and Jean Préaux, *Martianus Capella: De nuptiis Philologiae et Mercuri* Stuttgart (1969).
- Dichl, Ernest, *Procli Diadochi In Platonis Timaeum Commentaria* 3 Vols. Leipzig (1903–1906).
- Dichl, Ernest, *Anthologia Lyrica Graeca* 3rd Ed. Leipzig (1952).
- Diels, Hermann and Walther Kranz, *Die Fragmente der Vorsokratiker* 11th ed. Zurich (1985).

- Di Giulio, Anna Maria, "Iconografia degli strumenti musicali nell' arte Apula" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 108–120.
- Doutzaris, P., "La rythmique dans la poésie et la musique des Grecs anciens" *Revue des études grecques* 47 (1934) 297–345.
- Dumoulin, Dorothee, "Die Chelys Ein altgriechisches Saiteninstrument." *Archiv für Musikwissenschaft* 49 (1992) 85–109, 225–57.
- Düring, Ingemar, *Die Harmonielehre des Klaudios Ptolemaios* Göteborg (1930) Repr. New York (1980).
- Düring, Ingemar, *Porphyrios Kommentar zur Harmonielehre des Ptolemaios* Göteborg (1932) Repr. New York (1980).
- Düring, Ingemar, *Ptolemaios und Porphyrios über die Musik* Göteborg (1934) Repr. New York (1980).
- Düring, Ingemar, "Studies in Musical Terminology in Fifth Century Literature" *Eranos* 43 (1945) 176–197.
- Düring, Ingemar, "Greek Music: its Fundamental Features and its Significance" *Journal of World History* 3 (1956) 302–29.
- Düring, Ingemar, *Aristotle in the Ancient Biographical Tradition* Göteborg (1957).
- Duse, Ugo, "Das Scholion zu Aristides Quintilianus 3, 2 S. 98, 8–21 W.-I." *Philologus* 120 (1976) 309–13.
- Duse, Ugo, "La lira di Ione di Chio" *Quaderni Urbinati di Cultura Classica* 3 (1980) 113–23.
- Duysinx, François, "Asclépiodote et le monocorde" *L'Antiquité classique* 38 (1969) 447–58.
- Duysinx, François, "Homère et les instruments de musique" *Didaskalikon* 38 (1977) 17–22.
- Duysinx, François, "Accents, mélodie et modalité dans la musique antique" *L'Antiquité classique* 50 (1981) 306–17.
- Duysinx, François, "Aristide Quintilien et les modes musicaux antiques" *Serta Leodiensa Secunda* (ed. Arthur Bodson) Liège (1992) 159–171.
- Eggar, K., "Emotion and Morals in Greek Music" *Music and Letters* 11 (1930) 124–128.
- Einarson, B. and P. H. De Lacy, *Plutarch, Moralia* Vol. XIV, Cambridge, Mass. (1967).
- Eitrem, S., Amundsen, L., and Winnington-Ingram, R. P., "Fragments of Unknown Greek Tragic Texts with Musical Notation" *Symbolae Osloenses* 31 (1955) 1–87.
- Else, Gerald F., "Imitation in the fifth century" *Classical Philology* 53 (1958) 73–90, 245.
- Evieux, P., and Paul Burguière, *Cyrille d'Alexandrie* Paris (1985).
- Farmer, Henry George, "Greek Theorists of Music in Arabic Translation" *Isis* 13 (1930) 325–33.
- Feaver, Douglas D., "The Musical Setting of Euripides' *Orestes*" *American Journal of Philology* 81 (1960) 1–15.

- Festugière, A. J., "L'Âme et la Musique d'après Aristide Quintilien" *Transactions of the American Philological Association* 85 (1954) 55–78.
- Festugière, A. J., *Proclus: Commentaire sur le Timée* 5 Vols. Paris (1966).
- Flammini, Guiseppe, "Il proemium del De Istitutione Musica di Boezio" in *Prefazione, prologhi proemi di opere tecnicoscience latine* Vol 1. Rome (1990) 195–215.
- Fleming, Thomas, "The Harmonics of Nicomachus and the Pythagorean Tradition Flora R. Levin" Review *Classical Journal* 71 (1976) 277–8.
- Fleming, Thomas, "The Musical Nomos in Aeschylus' *Oresteia*" *Classical Journal* 72 (1977) 222–233.
- Fleming, Thomas, "The *Versus* in Greek Metrics and Music" *Quaderni Urbinati di Cultura Classica* 52 (1996) 123–131.
- Franchi, Saverio, "Monodia e coro: Tradizione classica, scritti critici e origini del melodramma. Sopravvivenze di una danza greca nell' Europa medievale e moderna" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 35–71.
- Fraser, P. M., "The World of Theophrastus" in *Greek Historiography* (ed. Simon Hornblower) Oxford (1994) 167–191.
- Freeman, Kathleen, *Companion to the Pre-Socratic Philosophers* Oxford (1946).
- Freeman, Kathleen, *Ancilla to the Pre-Socratic Philosophers* Oxford (1962).
- Friedlein, Godofred, *Boethius, De institutione arithmetica libri duo. De institutione musica libri quinque* Leipzig (1867) Repr. Frankfurt (1966).
- Fritz, Kurt von, *Pythagorean Politics in Southern Italy: An Analysis of the Sources* New York (1940).
- Gamba, Olga, "Il nomos policefalo" *Dioniso* 6 (1938) 235–52.
- Gamberini, Leopoldo, *Plutarco, 'Della musica'* Firenze (1979).
- Garrod, Heathcote William, "The Hyporcheme of Pratinas" *Classical Review* 34 (1920) 129–36.
- Gentili, Bruno, "Griechische Lyrik und Musik" *Propyläen (Geschichte der Literatur* Vol. 1) (ed. Erika Wischer) Berlin (1981) 186–197.
- Gentili, Bruno "Metro e ritmo nella dottrina degli antichi e nella prassi della "performance" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988b) 5–16.
- Gentili, Bruno "La mousikè: trasmissione e recezione" in *Lo Specchio della Musica: Iconographia musicale nella ceramica di Spina* (eds. F. Berti and D. Restani) Bologna (1988c) 5–8.
- Gentili, Bruno, "Polemichetta metrica: "Anceps-biceps" nella *Tebaide* di Stesicoro?" *Quaderni Urbinati di Cultura Classica* 61 (1999) 89–91.
- Gentili, Bruno and Pietro Giannini, "Preistoria e formazione dell'esametro" *Quaderni Urbinati di Cultura Classica* 26 (1977) 7–51.
- Gentili, Bruno and Pretagostini, Roberto (eds.), *La musica in Grecia* Rome (1988a).
- Gentili, Bruno and Perusino, Franca (eds.), *Mousike: Metrica, ritmica e musica greca in memoria di Giovanni Comotti* Pisa (1995).

- Georgiades, Thrasybulos, *Musik und Rhythmus bei den Griechen. Zum Ursprung der abendländischen Musik* Hamburg (1958).
- Gerber, Douglas E., *Greek Iambic Poetry: From the Seventh to the Fifth Centuries BC* Cambridge, Mass. (1999)
- Gevaert, François Auguste, *Histoire et théorie de la musique de l'antiquité* 2 Vols. Ghent (1875–81) Repr. Hildesheim (1965).
- Giannantoni, Gabriele, "Su alcuni problemi circa i rapporti tra scienza e filosofia nell'età ellenistica" in *La Scienza Ellenistica* (G. Giannantoni and M. Vegetti eds.) Naples (1984) 39–71.
- Giannarás, Anastasios, "Das Wachthaus im Bezirk der Musen: zum Verhältnis von Musik und Politik bei Platon" *Archiv für Musikwissenschaft* 32 (1975) 165–83.
- Gignon, Olof, "Zum antiken Begriff der Harmonie" *Studium generale* 19 (1966) 539–47.
- Ginaert, G. and Thonnard, F. J., *Augustinus, De musica libri sex* Bruges (1947).
- Godwin, Joscelyn, *The Harmony of the Spheres: A Sourcebook of the Pythagorean Tradition in Music* Rochester (1993).
- Goldhill, Simon and Osborne, Robin (eds.), *Performance Culture and Athenian Democracy* Cambridge (1999).
- Gombosi, Otto, *Die Tonarten und Stimmungen der antiken Musik* Copenhagen (1939).
- Gombosi, Otto, "The Melody of Pindar's "Golden Lyre"" *Musical Quarterly* 26 (1940) 381–92.
- Gombosi, Otto, "New Light on Ancient Greek Music" *Papers read at the International Congress of Musicology, New York, 1939* (eds. A. Mendel, G. Reese and G. Chase) New York (1944) 168–183.
- Gombosi, Otto, "Key, Mode, Species" *Journal of the American Musicological Society* 4 (1951) 20–26.
- Gomperz, Theodor, *Philodemus of Gadara: De Pietate* Leipzig (1866).
- Görgemanns, Herwig, and Annemarie Jeanette Neubecker, "'Heterophonic" bei Platon" *Archiv für Musikwissenschaft* 23 (1966) 151–69.
- Gostoli, Antonietta, "Terpandro e la funzione etico-politica della musica nella cultura spartana del VII sec. A. C." in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 231–7.
- Gostoli, Antonietta, "Il *nomos* citarodico nella cultura greca arcaica" in *Tradizione e innovazione nella cultura-greca da Omero all'età ellenistica: Scritti in onore di B. Gentili* Vol. 2 (ed. R. Pretagostini) Rome (1993) 167–78.
- Gostoli, Antonietta, "L'armonia frigia nei progetti politico-pedagogici di Platone e Aristotele" in *Mousike: Metrica, ritmica e musica-greca in memoria di Giovanni Comotti* (ed. B. Gentili and F. Perusino) Pisa (1995) 133–44.
- Gostoli, Antonietta, "Stesicoro la tradizione citarodica" *Quaderni Urbinati di Cultura Classica* 59 (1998) 145–152.
- Gottschalk, H. B., "The *De Audilibus* and Peripatetic Acoustics" *Hermes* 96 (1968) 435–60.

- Gottschalk, H. B., "Notes on the Wills of the Peripatetic Scholarchs" *Hermes* 100 (1972) 314–342.
- Greaves, Denise Davidson, *Sextus Empiricus: ΠΡΟΣ ΜΟΥΣΙΚΟΥΣ Against the Musicians (Adversus Musikos)* Lincoln (1986).
- Greif, F., "Études sur la musique antique" *Revue des études grecques* 22 (1909) 89–139; 23 (1910) 1–48; 24 (1911) 233–86; 26 (1913) 273–346; 27 (1914) 1–34.
- Grenfell, Bernard P., and Arthur Surridge Hunt, "IX. Aristoxenus ΠΥΘΜΙΚΑ ΣΤΟΙΧΕΙΑ" *Oxyrhynchus Papyri* 1 (1898) 14–21; Plate III.
- Grenfell, Bernard P. and Arthur Surridge Hunt "667. Aristoxenus?" *Oxyrhynchus Papyri* IV (1904) 86–90.
- Grenfell, Bernard P., and Arthur Surridge Hunt, *The Hibeh Papyri, Part I* London (1906) 45–48; Plate V.
- Grieser, Heinz, *Nomos: ein Beitrage zur griechischen Musikgeschichte* Heidelberg (1937).
- Guillemin, Marcelle, and Jacques Duchesne, "Sur l'origine asiatique de la cithare greque" *L'Antiquité classique* 4 (1935) 117–24.
- Gulick, Charles Burton, *Athenaeus: The Deipnosophists* 7 Vols. Cambridge Mass. (1950).
- Guthrie, W. K. C., *The Earlier Presocratics and the Pythagoreans (A History of Greek Philosophy Vol. I)* Cambridge (1971).
- Guthrie, K. S., *The Pythagorean Sourcebook and Library: An Anthology of Ancient Writings which Relate to Pythagoras and Pythagorean Philosophy* Grand Rapids (1988).
- Haase, Rudolf, "Ein Beitrage Platons zur Tetraktys" *Antaios* 11 (1969) 85–91.
- Haase, Rudolf, *Geschichte des harmonikalen Pythagoreismus* Vienna (1969).
- Habicht, Christian, "Hellenistic Athens and her Philosophers" *Athens in Hellenistischer Zeit* Munich (1994) 231–247.
- Hackforth, R. *Plato: Phaedrus* Oxford (1901).
- Hadot, P., "Les divisions des parties de la philosophie dans l'antiquité" *Museum Helveticum* 36 (1979) 201–23.
- Haldane, J. A., "Musical Instruments in Greek Worship" *Greece and Rome* 13 (1966) 98–107.
- Handschin Jacques, "Musikalische Miszellen" *Philologus* 86 (1931) 52–87.
- Handschin, Jacques, "The 'Timaeus' Scale" *Musica Disciplina* 4 (1950) 3–42.
- Handschin, Jacques, *Gedenkschrift Jacques Handschin* (ed. P. Haupt) Bern (1957).
- Handschin, Jacques, "Die alte Musik als Gegenwartsproblem" in *Gedenkschrift Jacques Handschin* Bern (1957) 338–341.
- Handschin, Jacques, "Der Begriff der Form in der Musik" in *Gedenkschrift Jacques Handschin* Bern (1957) 332–337.
- Handschin, Jacques, "Die Lehre von der Sphärenharmonie" in *Gedenkschrift Jacques Handschin* Bern (1957) 359–364.
- Handschin, Jacques, "Die Sphärenharmonie in der Geistesgeschichte" in *Gedenkschrift Jacques Handschin* Bern (1957) 365–369.

- Hanning, Barbara R., and Nancy K. Baker (eds.), *Musical Humanism and its Legacy: Essays in Honor of Claude V. Palisca* New York (1992).
- Harap, Louis, "Some Hellenic Ideas on Music and Character" *Musical Quarterly* 24 (1938) 153–168.
- Hardie, R. P. and R. K. Gaye, *Aristotle: Physics* Oxford (1962).
- Harmon, A. M., et al. *The Works of Lucian* 8 Vols. London (1913–1967).
- Harvey, A. E., "The Classification of Greek Lyric Poetry" *Classical Quarterly* n.s. 5 (1955) 157–175.
- Haslam, Michael W., "3161 and 3162. Texts with Musical Notation" *Oxyrhynchus Papyri* 44 (1976) 58–72; Plates VI, VII.
- Haslam, Michael W., "3704 and 3705. Texts with Musical Notation" *Oxyrhynchus Papyri* 53 (1986) 41–48; Plates II, IV, VI.
- Haslam, Michael W., "3706. Treatise on Music" *Oxyrhynchus Papyri* 53 (1986) 49–55; Plate VII.
- Haslam, Michael W., "3707. Treatise on Meters" *Oxyrhynchus Papyri* 53 (1986) 56–60; Plate VII.
- Heath, Malcom, "Receiving the κῶμος: The Context and Performance of the Epinician" *American Journal of Philology* 109 (1988) 180–95.
- Heath, Thomas L., *Aristarchus of Samos, the Ancient Copernicus* Oxford (1913).
- Heath, Thomas L., *A History of Greek Mathematics* 2 Vols. Oxford (1921); Repr. New York (1981).
- Henderson, M. I., "The Growth of the Greek ἄρμονία" *Classical Quarterly* 36 (1942) 94–103.
- Henderson, M. I., "The Growth of Ancient Greek Music" *Music Review* 4 (1943) 4–13.
- Henderson M. I., "Ancient Greek Music" in *Ancient and Oriental Music* (New Oxford History of Music Vol. I) (ed. Egon Wellesz) Oxford (1957) 336–403.
- Henry, René, *Photius Bibliothèque* 8 Vols. Paris (1959–1977).
- Hett, W. S., *Aristotle: On the Soul* Cambridge Mass. (1936).
- Hickmann, Hans, "Eine Sonderform des griechischen Sistrums" in *Musa-Mens-Musici. Im Gedanken an Walther Vetter* (ed. H. Wegener) Leipzig (1969) 27–28.
- Hicks, R. D., *Diogenes Laertius: Lives of Eminent Philosophers* 2 Vols. Cambridge, Mass. (1925).
- Higgins, R. A. and R. P. Winnington-Ingram, "Lute-Players in Greek Art" *Journal of Hellenic Studies* 85 (1965) 61–71; Plates XVI, XVII.
- Hiller, E., *Theonis Smyrnaei Platonici Mathematica* Leipzig (1878).
- Hirzel, Rudolf, "Aristoxenos und Platons erster Alkibiades" *Rheinisches Museum* 45 (1890) 419–35.
- Höeg, C., "Porphyrios Kommentar zur Harmonielehre des Ptolomaïos, Heraus. von Ingemar Düring" *Gnomon* 10 (1934) 318–326.
- Höeg, C., "Ingemar Düring: Ptolomaïos und Porphyrios Über die Musik" *Gnomon* 12 (1936) 152–157.
- Holder, Alfred, *Pomponi Porphyronis: Commentum in Horatium Flaccum Ad Aeni Pontem* (1894).

- Holzer, Ernst, "Zu Philodemos περί μουσικῆς" *Philologus* 66 (1907) 498–502.
- Hornbostel, Erich M. von, "Tonart und Ethos" in *Festschrift für Johannes Wolf zu seinem sechzigsten Geburtstag* (eds. W. Lott, H. Osthoff und W. Wolffheim) Berlin (1929) 73–78.
- Horowitz, Mindy B., "Modulation and the *Tonoí* According to Aristides Quintilianus" *Theoria* 1 (1985) 84–96.
- Howald, Ernst, "Eine vorplatonische Kunsttheorie" *Hermes* 54 (1919) 187–207.
- Huffman, Carl A., "The Authenticity of Archytas Fr. 1" *Classical Quarterly* 35 (1985) 344–8.
- Huffman, Carl A., *Philolaus of Croton, Pythagorean and Presocratic* Cambridge (1993).
- Huglo, Michel, "Bibliographie des éditions et études relatives à la théorie musicale du Moyen Âge (1972–1987)" *Acta Musicologica* 60 (1988) 229–72.
- Hunt, Arthur Surridge, and H. S. Jones, "1786. Christian Hymn with Musical Notation" *Oxyrhynchus Papyri* 15 (1922) 21–25; Plate I.
- Husmann, Heinrich, "Zu Metrik und Rhythmik des Mesomedes" *Hermes* 83 (1955) 231–236.
- Husmann, Heinrich, *Grundlagen der Antiken und Orientalischen Musikkultur* Berlin (1961).
- Issberger, Reinhold, "Dynamis und Thesis" *Philologus* 55 (1896) 541–60.
- Izzo, Assunta, "Musica e Numero da Ippaso ad Archita" *Forme del Sapere nei Presocratici* (eds. A. Capizzi and G. Casertano) Rome (1987) 137–167.
- Jaeger, Werner, "Diokles von Karystos und Aristoxenos von Tarent über die Prinzipien" **ΕΡΜΗΝΕΙΑ: Festschrift Otto Regenbogen** Heidelberg (1952) 94–103.
- Jaeger, Werner, *Aristotle: Metaphysics* Oxford (1969).
- Jahn, O., *Censorinus: De die natali* Berlin (1845) Repr. Hildesheim (1964).
- Jan, Carl von, *Musici Scriptores Graeci* Leipzig (1895) Repr. Hildesheim (1962).
- Joachim, H. H., *Aristotle: On Coming-to-be and Passing-away* Oxford (1922).
- John, Hans, "Das musikerzieherische Wirken Pythagoras' und Damons" *Die Altertum* 8 (1962) 67–72.
- John, Hans, "Die griechische Musikerziehung während des Hellenismus und der Kaiserzeit" in *Musa-Mens-Musici. Im Gedanken an Walther Vetter* (ed. H. Wegener) Leipzig (1969) 29–32.
- Johnson, William, "Musical Evenings in the Early Empire: New Evidence from a Greek Papyrus with Musical Notation" *Journal of Hellenic Studies* 120 (2000) 57–85.
- Jones, H. L., *The Geography of Strabo* Vol. I Cambridge Mass. (1917).
- Jones, H. Stuart, "Monroe on Greek Music" *Classical Review* 8 (1894) 448–454.
- Jonker, G. H., *Bryennius: Harmonics* Groningen (1970).
- Jourdan-Hemmerdinger, Denise, "Un nouveau papyrus musical d'Euripide (présentation provisoire)" *Comptes rendus de l'Académie des Inscriptions et Belles-Lettres* (1973) 292–302.
- Jourdan-Hemmerdinger, Denise, "Nouveaux fragments musicaux sur papyrus (une notation antique par points)" *Studies in Eastern Chant* 4 (1979) 81–111.

- Jourdan-Hemmerdinger, Denise, "Le date de la 'notation vocale' d'Alypius" *Philologus* 125 (1981) 299–303.
- Jourdan-Hemmerdinger, Denise, "Une livre récent sur la musique grecque antique" *Quaderni Urbinati di Cultura Classica* 12 (1982) 145–163.
- Jourdan-Hemmerdinger, Denise, "L'epigramma di Pitecusa e la musica della Grecia antica" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 145–182.
- Junge, Gustav, "Die Sphären-harmonic und die pythagoreisch-platonische Zahlenlehre" *Classica et Mediaevalia* 9 (1947) 183–94.
- Kaden, Christian, "Die Stelling der Berufsmusiker in der Gesellschaft des antiken Griechenland" *Beiträge zur Musikwissenschaft* 11 (1969) 47–66.
- Kassel, R., *Aristotle: Ars Rhetorica* Berlin (1976).
- Kassel, R., and Austin, C., *Poetae Comici Graeci* Vol. 7 Berlin (1989)
- Kassler, Jamie C., "The 'Science' of Music to 1830" *Archives internationales d'histoire de sciences* 30 (1980) 109–136.
- Kassler, Jamie C., "Apollo and Dionysos: Music Theory and the Western Tradition of Epistemology" *Music and Civilisation: Essays in Honor of Paul Henry Lang* (eds. E. Strainchaps and M. Maniates) New York (1984).
- Keaney, John, *Harpocraton, Lexeis of the Ten Orators* Amsterdam (1991).
- Keller, Otto, *Rerum Naturalium Scriptores Graeci Minores* Vol. 1 Leipzig (1877).
- Keller, Otto, *Pseudacronis Scholia in Horatium Vetustiora* Leipzig (1902–4).
- Kemke, J., *Philodemi De Musica Librorum quae extant* Leipzig (1884).
- Kemp J. A., "Professional Musicians in Ancient Greece" *Greece and Rome* 13 (1966) 213–222.
- Kennedy, Michael (ed.), *The Oxford Dictionary of Music* Oxford (1985).
- Kilmer, Anne Draffkorn, "The Musical Instruments from Ur and Ancient Mesopotamian Music" *Expedition* 40 (1988) 12–28.
- Kilmer, Anne Draffkorn, "The Discovery of an Ancient Mesopotamian Theory of Music" *Proceedings of the American Philosophical Society* 115 (1971) 131–149.
- King, J. E. *Cicero: Tusculan Disputations* Cambridge, Mass. (1945).
- Kinkeldey, Otto, "The Music of the Spheres" *Bulletin of the American Musicological Society* 11–13 (1948) 30–32.
- Kirk, G. S., and J. E. Raven, *The Presocratic Philosophers* Cambridge 1st ed. (1957); 2nd ed. with M. Schofield (1983).
- Klitos Ioannides, Nicosie, "L'éthos musical chez Platon" *Philosophia* 15–16 (1985–6) 254–265.
- Koch, Hans Albrecht, "Protagoras bei Platon, Aristoteles und Sextus Empiricus" *Hermes* 99 (1971) 278–82.
- Koller, Ernst, "Musse und musische Paideia" *Museum Helveticum* 13 (1956) 1–37 and 94–124.
- Koller, Hermann, *Die Mimesis in der Antike* Bern (1954).
- Koller, Hermann, "Zum Aufsatz über 'Harmonic und Tetraktys'" *Museum helveticum* 17 (1960) 115–117.

- Koller, Hermann, *Musik und Dichtung im alten Griechenland* Bern (1963).
- Koller, Hermann, "Musik bei Platon und den Pythagoreern" *Propyläen (Geschichte der Literatur Vol. I)* (ed. Erika Wischer) Berlin (1981) 275–288.
- Koster, W. J. W., "Dactylepitriti an Metra Choriambo-ionica?" *Classical Quarterly* 28 (1934) 145–155.
- Koster, W. J. W., "Quaestiones Metricae" *Mnemosyne* XII (1945) 161–180.
- Koster, W. J. W., "Quelques Remarques sur l'Étude de Rhythmique Oxy. Pap. 2687 (9)" *Revue des Etudes Grecques* 85 (1972) 47–56.
- Kucharski, Paul, "La musique et la conception du réel dans le 'Philebe'" *Revue philosophique* 141 (1951) 39–59.
- Kucharski, Paul, "Le 'Philèbe' et les 'Éléments harmoniques' d'Aristoxène" *Revue philosophique* 149 (1959) 41–72.
- Kytzler, B., "Die Weltseele und der musikalische Raum" *Hermes* 87 (1959) 393–414.
- Laloy, Louis, "Quels sont les accords cités dans le ch. XIX du *περὶ μουσικῆς*?" *Revue de philologie* 23 (1899) 132–40.
- Laloy, Louis, *Aristoxène de Tarente, disciple d'Aristote, et la musique de l'antiquité* Paris (1904); Repr. Genève (1973).
- Lambin, Gérard, *La chanson grecque dans l'antiquité* Paris (1992).
- Landels, John G., "Music in Ancient Greece" *Proceedings of the Classical Association* 77 (1980) 24.
- Landels, John G., *Music in Ancient Greece and Rome* London (1999).
- La Ruc, Jan (ed.), *Aspects of Medieval and Renaissance Music: A Birthday Offering to Gustave Reese* New York (1966).
- Latte, Kurt, *Hesychii Alexandrini Lexicon* Vol. II Hauniae (1966).
- Lissarrague, François, "Dionysos Musicos: Une Note" Vecchia and Restani (eds.), *Trent'anni di Ricerca Musicologica: Studi in Onore di F. Alberto Gallo* Rome (1996) 355–361.
- Lasserre, François, *Plutarque: De La Musique* Olten (1954).
- Lasserre, François, "Musica babilonese e musica greca" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 72–95.
- Lawlor, Robert and Deborah, *ΘΕΟΝΟΣ ΣΜΥΡΝΑΙΟΥ Mathematics Useful for Understanding Plato* California (1979).
- Lear, J., "Aristotle's Philosophy of mathematics" *Philosophical Review* 91 (1982) 161–91.
- Lefkowitz, Mary R., "Who sang Pindar's victory odes?" *American Journal of Philology* 109 (1988) 1–11.
- Leo, Friedrich, *Die griechisch-römische Biographie nach ihrer litterarischen Form* Leipzig (1901).
- Letters, Richard J., "The Scales of Some Surviving AULOI" *Classical Quarterly* 19 (1969) 266–8.
- Levin, Flora Rose, "The Hendecachord of Ion of Chios" *Transactions of the American Philological Association* 92 (1961) 295–307.

- Levin, Flora Rose, "Synesis in Aristoxenian theory" *Transactions of the American Philological Association* 103 (1972) 211–234.
- Levin, Flora Rose, *The Harmonics of Nicomachus and the Pythagorean Tradition* Philadelphia (1975).
- Levin, Flora Rose, "πληγὴ and τᾶσις in the Harmonika of Klaudios Ptolemaios" *Hermes* 108 (1980) 205–229.
- Levin, Flora Rose, "Unity in Euclid's 'Sectio Canonis'" *Hermes* 118 (1990) 430–43.
- Levin, Flora Rose, *The Manual of Harmonics of Nicomachus the Pythagorean* Grand Rapids (1994).
- Lippman, Edward A., "Hellenic Conceptions of Harmony" *Journal of the American Musicological Society* 16 (1963) 3–35.
- Lippman, Edward A., "The Sources and Development of the Ethical View of Music in Ancient Greece" *Musical Quarterly* 49 (1963) 188–209.
- Lippman, Edward A., *Musical Thought in Ancient Greece* New York (1964).
- Lippman, Edward A., "The Place of Music in the System of Liberal Arts" (ed. Jan La Rue) *Aspects of Medieval and Renaissance Music* New York (1966) 545–559.
- Litchfield, Malcolm, "Aristoxenus and Empiricism: A Reevaluation Based on his Theories" *Journal of Music Theory* 32 (1988) 51–73.
- Lloyd, G. E. R., "Aspects of Science, Folklore and Ideology in the Ancient World" in *La Scienza Ellenistica* (G. Giannantoni and M. Vegetti eds.) Naples (1984) 395–426.
- Lloyd, G. E. R., "Plato and Archytas in the Seventh Letter" *Phronesis* 35 (1990) 159–174.
- Lloyd, G. E. R., *Aristotelian Explorations* Cambridge (1996).
- Lohmann, Johannes, "Die griechische Musik als mathematische Form" *Archiv für Musikwissenschaft* 14 (1957) 147–55.
- Lohmann, Johannes, "Der Ursprung der Musik" *Archiv für Musikwissenschaft* 16 (1959) 148–73, 261–291, 400–403.
- Lohmann, Johannes, *Musiké et Logos: Aufsätze zur griechischen Philosophie und Musiktheorie zum 75. Geburtstag des Verfassers am 9. Juli (1970)* (ed. A. Giannarás) Stuttgart (1970).
- Long, A. A., "The Harmonics of Stoic Virtue" in *Aristotle and the Later Tradition* (ed. H. Blumenthal, H. Robinson and A. C. Lloyd) Oxford (1991) 97–116.
- Lord, Carnes, "A Peripatetic Account of the Tragic Muse" *Hermes* 105 (1977) 175–9.
- Lord, Carnes, "On Damon and Music Education" *Hermes* 106 (1978) 32–43.
- Lord, Carnes, "Politics and Philosophy in Aristotle's *Politics*" *Hermes* 106 (1978) 336–57.
- Lord, Carnes, *Education and Culture in the Political Thought of Aristotle* Ithica (1982).
- Lynch, J. P., *Aristotle's School* California (1972).
- Maas, Martha, "On the shape of the ancient Greek lyre" *Galpin Society Journal* 27 (1974) 113–7.
- Maas, Martha, "Back Views of the Ancient Greek Kithara" *Journal of Hellenic Studies* 95 (1975) 175; Plate XIXa.

- Maas, Martha, "The Phorminx in Classical Greece" *Journal of the American Musical Instrument Society* 2 (1976) 34–55.
- Maas, Martha, "Polychordia and the Fourth-Century Greek Lyre" *Journal of Musicology* 10 (1992) 74–88.
- Maas, Martha, "Timotheus at Sparta: The Nature of the Crime" in *Musical Humanism and its Legacy: Studies in Honor of Claude V. Palisca* (ed. N. Baker and B. Hanning) New York (1992) 37–52.
- Maas, Martha, and Jane McIntosh Snyder, *Stringed Instruments of Ancient Greece* New Haven (1989).
- MacLachlan, Bonnie, "The Harmony of the Spheres: *Dulcis Sonus*" in *Harmonia Mundi: Musica e filosofia nell'antichità* (ed. R. Wallace and B. MacLachlan) Rome (1991) 7–19.
- Macran, Henry, *The Harmonics of Aristoxenus* Oxford (1902) Repr. Hildesheim (1990).
- Marrou, Henri Irénée, "ΜΕΛΟΓΡΑΦΙΑ" *L'Antiquité classique* 15 (1946) 289–296.
- Marrou, Henri Irénée, *Histoire de l'éducation dans l'antiquité* Paris (1948); Trans. George Lamb *A History of Education in Antiquity* London (1956).
- Marzi, Giovanni, *Melodia e Nomos Nella Musica Bizantina* Bologna (1960).
- Marzi, Giovanni, "Il Papiro Musicale dell' 'Oreste' di Euripide" *Scritti in onore di Luigi Ronga* Milan (1973) 315–29.
- Marzi, Giovanni, "Il 'Decreto' degli Sptani contro Timoteo (Boeth., 'De Instit. Mus.' 1, 1)" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 264–72.
- Mathiesen, Thomas J., *A Bibliography of Sources for the Study of Ancient Greek Music* New Jersey (1974).
- Mathiesen, Thomas J., "An Annotated Translation of Euclid's Division of a Monochord" *Journal of Music Theory* 19 (1975) 237–259.
- Mathiesen, Thomas J., "Towards a Corpus of Ancient Greek Music Theory. A New Catalogue Raisoné Planned for *RISM*" *Fontes Artis Musicae* 25 (1978) 119–34.
- Mathiesen, Thomas J., "New Fragments of Ancient Greek Music" *Acta Musicologica* 53 (1981) 14–32.
- Mathiesen, Thomas J., "Aristides Quintilianus and the *Harmonics* of Manuel Bryennius: A Study in Byzantine Music Theory" *Journal of Music Theory* 27 (1983) 31–47.
- Mathiesen Thomas J., *Aristides Quintilianus: On Music in Three Books* New Haven (1983).
- Mathiesen, Thomas J. "Harmonia and Ethos in Ancient Greek Music" *Journal of Musicology* 3 (1984) 264–279.
- Mathiesen, Thomas J., "Rhythm and Meter in Ancient Greek Music" *Music Theory Spectrum* 7 (1985) 159–80.
- Mathiesen, Thomas J., *Ancient Greek Music Theory: A Catalogue raisonné of Manuscripts* RISM BXI Munich (1988).

- Mathiesen, Thomas J., "Music, Aesthetics, and Cosmology in Early Neo-Platonism" *Paradigms in Medieval Thought* (ed. N. van Deusen and A. E. Ford) Lewiston, New York (1990) 37–64.
- Mathiesen, Thomas J., "Hermes or Clio? The Transmission of Ancient Greek Music Theory" in *Musical Humanism and its Legacy: Studies in Honor of Claude V. Palisca* (ed. N. Baker and B. Hanning) New York (1992) 3–35.
- Mathiesen, Thomas J. (ed.), *Greek Views of Music (Strunk's Source Readings in Music History Vol. I)* New York (1998).
- Mathiesen, Thomas J., *Apollo's Lyre* Lincoln (1999).
- Mau, Jürgen, "Πρὸς μουσικούς" in *Sexti Empirici Opera* Vol 4. Leipzig (1954–62).
- McClain, Ernest G., "Musical 'Marriages' in Plato's Republic" *Journal of Music Theory* 18 (1974) 243–273.
- McClain, Ernest G., *The Pythagorean Plato: Prelude to the Song Itself* Stony Brook, New York (1978).
- McKinnon, James W., "The Rejection of the Aulos in Classical Greece" *Music and Civilisation: Essays in Honor of Paul Henry Lang* (ed. E. Strainchaps and M. Maniates) New York (1984) 203–14.
- McKinnon, James W. (ed.), *The Early Christian Period and the Latin Middle Ages (Strunk's Source Readings in Music History Vol. II)* New York (1998).
- Meinecke, Bruno, "Music and Medicine in Classical Antiquity" *Music and Medicine* (ed. D. Schullian and M. Schoen) New York (1948) 47–95.
- Michaelides, Solon, *The Music of Ancient Greece: an Encyclopaedia* London (1978).
- Mills, Michael J., "Τύχη in Aristoxenus, Fr. 41, and Eudemian Ethics Q.2." *American Journal of Philology* 103 (1982) 204–208.
- Monroe, David Binning, *The Modes of Ancient Greek Music* Oxford (1894).
- Montanari, Franco, *Studi di Filologia Omerica Antica* I Pisa (1979).
- Moraux, Paul, "La 'mimesis' dans les théories anciennes de la danse, de la musique, et de la poésie" *Études classiques* 23 (1955) 3–13.
- Mosshammer, Alden A., "Geometrical Proportion and the Chronological Method of Apollodorus" *Transactions of the American Philological Association* 106 (1976) 291–306.
- Mountford, James Frederick, "Greek Music in the Papyri and Inscriptions" *New Chapters in the History of Greek Literature* 2nd series. Oxford (1929) 146–183.
- Mountford, James Frederick, "The Musical Scales of Plato's Republic" *Classical Quarterly* 17 (1923) 125–136.
- Mountford, James Frederick, "The Harmonics of Ptolemy and the Lacuna in II, 14" *Transactions of the American Philological Association* 57 (1926) 71–95.
- Mountford, James Frederick, "The Music of Pindar's 'Golden Lyre'" *Classical Philology* 31 (1936) 120–136.
- Mountford, James Frederick, and R. P. Winnington-Ingram, "Music" *Oxford Classical Dictionary* 2nd Ed. Oxford (1970) 705–13.
- Moutsopoulos, Evaghélou, *La philosophie de la musique dans la dramaturgie antique: Formation et Structure* Athens (1975).

- Moutsopoulos, Evanhélou, "Science harmonique et empirisme musical chez Platon" *Actes du XXIIe Congrès international d'histoire des sciences* Paris. (1971) 3A: 109–12.
- Moutsopoulos, Evanhélou, *La musique dans l'oeuvre de Platon* Paris (1959).
- Moyer, Ann E., *Musical Scholarship in the Italian Renaissance* Ithaca (1992).
- Mras, Karl, *Eusebius Werke: Die Praeparatio Evangelica* Vol. II Berlin (1956).
- Mueller, Ian, "Ascending to problems: astronomy and harmonics in *Republic VII*" in *Science and the Sciences in Plato* (ed. J. P. Anton) New York (1980) 103–121.
- Mueller, Ian, "Peri ton Mathematon" *Apeiron* 24 (1991) 49–83.
- Mynors, R. A. B., *Cassiodorus, Institutiones divinarum et saecularium litterarum* Oxford (1937).
- Najock, Dietmar, *Drei anonyme griechische Traktate über die Musik: Eine kommentierte Neuauflage des Bellermannschen Anonymus* Kassel (1972).
- Najock, Dietmar, *Anonyma de musica scripta Bellermanniana* Leipzig (1975).
- Najock, Dietmar, "Aristoxenos und die Auloi" *Worte, Bilder, Töne. Studien zur Antike und Antikerezeption* (ed. R. Faber, B. Seidensticker, B. Kytzler) Würzburg (1996) 59–76.
- Nauck, Augustus, *Lexicon Vindobonense* Petrofoli (1867) repr. Hildesheim (1965).
- Neubecker, A. J., *Die Bewertung der Musik bei Stoikern und Epikureern* Berlin (1956).
- Neubecker, A. J., *Altgriechische Musik: Eine Einführung* Darmstadt (1977).
- Neubecker A. J., *Philodemus—Über die Musik, Viertes Buch* La scuola di Epicuro 4 Naples (1986).
- Neubecker, A. J., "Altgriechische Musik 1958–1986" *Lustrum* 32 (1990) 99–176, 293–296.
- Nickau, Klaus, *Ammonii De Adfinium Vocabulorum Differentia* Leipzig (1966).
- Pagliara, A., "Alcune considerazioni in merito alla teoria musicale greca: Archita e Aristosseno tra Pitagora e Platone" *Quaderni del Dipartimento di Scienze Archeologiche e Storiche dell'Antichità dell'Università di Macerata* 1 (1996) 35–69.
- Palisca, Claude V., "Scientific Empiricism in Musical Thought" in *Seventeenth Century Science and the Arts* (ed. H. H. Rhys) Princeton (1961) 91–137.
- Palisca, Claude V., "Introductory Notes on the Historiography of the Greek Modes" *Journal of Musicology* 3 (1984) 221–228.
- Palisca, Claude V., "Giovanni Battista Doni's Interpretation of the Greek Modal System" *Journal of Musicology* 15 (1997) 3–18.
- Paribeni, Enrico, "La cccramografia attica: una chiave di lettura" in *Lo Specchio della Musica: Iconographia musicale nella ceramica di Spina* (eds. F. Berti and D. Restani) Bologna (1988) 1–4.
- Pearson, Lionel, *Aristoxenus: Elementa Rhythmica* Oxford (1990).
- Penella, Robert J., *The Private Orations of Themistius* Berkeley (2000).
- Perett, Wilfred, *Some Questions of Musical Theory* Cambridge (1926–28).
- Perrin, Bernadotte, *Plutarch's Lives* 11 Vols. Cambridge, Mass. (1914–1926).
- Perrin, Michel, *Lactance: L'ouvrage du dieu créateur* Paris (1974).

- Phillips, R. C., "Mean Tones, Equal Tempered Tones, and the Harmonic Tetrachords of Claudius Ptolemy" *Memoirs and Proceedings of the Manchester Literary and Philosophical Society* 48/13 (1904).
- Pickard-Cambridge A. W., *Dithyramb, Tragedy, Comedy*. 2nd Ed. Revised J. Gould and D. M. Lewis. Oxford (1968).
- Pizzani, Ubaldo, "Studi sulle fonte del 'De Institutione Musica' di Boezio" *Sacris Erudiri* 16 (1965) 5–164.
- Pizzani, Ubaldo, "Plinio, Boezio e la teoria pitagorica dell'armonia delle sfere" *Helmantica* 37 (1986) 185–199.
- Pistelli, H., *Iamblichi in Nicomachi Arithmetica Introductionem Liber* 2nd ed. with U. Klein, Leipzig (1975).
- Pöhlmann, Egert, *Griechische Musikfragmente: Ein Weg zur altgriechischen Musik* Nürnberg (1960).
- Pöhlmann, Egert, *Denkmäler altgriechischer Musik* Nürnberg (1970).
- Pöhlmann, Egert, *Beiträge zur antiken und neueren Musikgeschichte* Frankfurt am Maim (1988).
- Pöhlmann, Egert, "Oralità e scrittura ieri e oggi" in *Lo Specchio della Musica: Iconographia musicale nella ceramica di Spina* (eds. F. Berti and D. Restani) Bologna (1988) 19–28.
- Pöhlmann, Egert, "Sulla Preistoria della Tradizione di Testi e Musica per il Teatro" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 132–144.
- Pöhlmann, Egert, "Die Überlieferung der Musik in der antiken Welt" *Die Musikforschung* 44 (1991) 1–9.
- Pöhlmann, Egert, and M. L. West, *Documents of Ancient Greek Music* Oxford (2001).
- Potiron, Henri, *Boèce: Théoricien de la Musique Grecque* Paris (1961).
- Potiron, Henri, "Les notations d'Aristides Quintilien et les harmonies dites Platoniciennes" *Revue de musicologie* 47 (1961) 159–76.
- Potiron, Henri, "La notation grecque au temps d'Aristoxène" *Revue de musicologie* 50 (1964) 222–225.
- Pretagostini, Roberto, "Le prime due sezioni liriche delle *Nuvole* di Arisofane e i ritmi κατ' ἐνόπλιον e κατὰ δάκτυλον (*Nub.* 649–651)" *Quaderni Urbinati di Cultura Classica* 2 (1979) 119–129.
- Pretagostini, Roberto, "Parola, Metro e Musica nella Monodia dell'Upupa (Aristofane "Uccelli" 227–262)" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 189–198.
- Pretagostini, Roberto, *Tradizione e innovazione nella cultura greca da Omero all'età ellenistica: Scritti in onore di B. Gentili* 3 Vols. Rome (1993).
- Privitera, G. Aurelio "Il Dithirambo come Spettacolo Musicale: Il Ruolo di Archiloco e di Arione" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 123–131.
- Rackham, H., *Cicero De Finibus* Cambridge Mass. (1914).
- Rackham, H., *Cicero De Oratore* Cambridge Mass. (1942).

- Radermacher, Ludwig, "Ein Bruchstück des Damon" *Wiener Studien* 56 (1938) 110–111.
- Radermacher, Ludwig, "Metrisches" *Wiener Studien* 59 (1941) 1–11.
- Randel, Don M., "Al-Farabi and the Role of Arabic Music Theory in the Latin Middle Ages" *Journal of the American Musicological Society* 29 (1976) 173–88.
- Raubitschek, A. E., "Damon" *Classica et Mediaevalia* 16 (1955) 78–83.
- Rca, J., "Aristoxenus, Ῥυθμικὰ Στοιχεῖα? 2687" *Oxyrhynchus Papyri* 44 (1968) 15–25.
- Reinach, Théodore, "Les Nouveaux Fragments Rythmiques d'Aristoxène" *Revue des Etudes Grecques* 11 (1898) 389–415.
- Reinach, Théodore, "La Musique des Sphères" *Revue des études grecques* 13 (1900) 432–49.
- Reinach, Théodore, "Aristoxène, Aristote et Théophraste" *Festschrift für Theodor Gomperz dargebracht zum 70. Geburtstage am 29.III. 1902 von Schülern, Freunden, Collegen* Vienna (1902) 75–79.
- Reinach, Théodore, *La Musique Grecque* Paris (1926).
- Renchan, Robert, "The Derivation of ῥυθμός" *Classical Philology* 58 (1963) 36–8.
- Restani, Donatella, "Il *Chirone* di Ferecrate e la 'nuova' musica greca" *Rivista italiana di musicologica* 18 (1983) 139–92.
- Restani, Donatella, "In margine al *Chirone* di Ferecrate" *Rivista italiana di musicologica* 19 (1984) 203–5.
- Restani, Donatella, "Problemi Musicali nel XIV Libro dei "Deipnosophistai" di Atenco: Una Proposta di Lettura" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 26–34.
- Restani, Donatella (ed.), *Musica e Mito nella Grecia Antica* Bologna (1995).
- Richter, Lukas, "Platons Stellung zur praktischen und spekulativen Musiktheorie seiner Zeit" *Bericht über den Internationalen Musikwissenschaftlichen Kongress: Hamburg 1956*, (ed. W. Gerstenberg) Kassel (1957) 196–202.
- Richter, Lukas, "Die Aufgaben der Musiklehre nach Aristoxenos und Klaudios Ptolemaios" *Archiv für Musikwissenschaft* 15 (1958) 209–29.
- Richter, Lukas, "Die Beziehung zwischen Theorie und Praxis der Musik im aristotelischen Protrepikos" *Hermes* 88 (1960) 177–188.
- Richter, Lukas, *Zur Wissenschaftslehre von der Musik bei Platon und Aristoteles* Berlin (1961).
- Richter, Lukas, "Antike Überlieferungen in der byzantinischen Musiktheorie" *Deutsches Jahrbuch der Musikwissenschaft* 6 (1962) 75–115; Revised and expanded in *Acta Musicologica* 70 (1998) 133–208.
- Richter, Lukas, "Zeugnisse zur praktischen Musiklehre der Griechen in vorplatonischer Zeit" *Acta antiqua Philoppopolitana: studia historica et philologica* Serdicac (1963) 197–206.
- Richter, Lukas, "Die Neue Musik der griechischen Antike" *Archiv für Musikwissenschaft* 25 (1968) 1–8, 134–47.
- Richter, Lukas, "Musikalische Aspekte der attischen Tragödienchöre" *Beiträge zur Musikwissenschaft* 14 (1972) 247–98.

- Richter, Lukas, "Der Stilwandel der griechischen Musik zur Zeit der Poliskrise" in *Hellenische Poleis: Krise, Wandlung, Wirkung* (ed. Elisabeth Charlotte Welskopf) Berlin (1974) 1450–71.
- Richter, Lukas, "Die Stellung der Music in der aristotelischen 'Metaphysik'" *Aristoteles als Wissenschaftstheoretiker: Eine Aufsatzsammlung* (ed. J. Irmscher and R. Müller) Berlin (1983) 46–49.
- Riethmüller, Albrecht, "Die Hinfälligkeit musiktheoretischer Prinzipien nach Sextus Empiricus, *Adversus musicos*" *Archiv für Musikwissenschaft* 32 (1975) 184–95.
- Riethmüller, Albrecht, "Logos und Diastema in der griechischen Musiktheorie" *Archiv für Musikwissenschaft* 42 (1985) 18–36.
- Riethmüller, Albrecht, and Frieder Zaminer, *Die Musik der Altertums (Neues Handbuch der Musikwissenschaft Vol. 1)* Laaber (1989).
- Ring, F., "Zur altgriechischen Solmisationslehre" *Archiv für Musikforschung* 3 (1938) 193–208.
- Rispoli, G. M., "Il primo libro del περὶ μουσικῆς di Filodemo" *Ricerche sui papiri ercolanesi* I Naples (1969) 25–286.
- Rispoli, G. M., "Elementi di fisica e di etica epicurea nella teoria musicale di Filodemo di Gadara" in *Harmonia Mundi: Musica e filosofia nell'antichità* (ed. R. Wallace and B. MacLachlan) Rome (1991) 69–103.
- Rocconi, Eleonora, "Terminologia dello 'spazio sonoro' negli *Elementa Harmonica* di Aristosseno di Taranto" *Quaderni Urbinati di Cultura Classica* 61 (1999) 93–103.
- Rolfe, J. C., *Attic Nights of Aulus Gellius* Cambridge Mass. (1927).
- Rome, A., "L'origine de la prétendue mélodie de Pindare" *Études Classiques* 1 (1932) 3–11.
- Ross, W. D., *Aristotle: Posterior Analytics* Oxford (1968).
- Ross, W. D., *Aristotle: Metaphysics* 2 Vols. Oxford (1924).
- Rossi, Luigi Enrico, "La dottrina dell' "éthos" musicale e il simposio" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 238–245.
- Rowell, Lewis, "Aristoxenus on Rhythm" *Journal of Music Theory* 23 (1979) 63–79.
- Ruelle, Charles-Emile, "Le Fragment Musical d'Oxyrhynchus" *Revue de Philologie* 29 (1905) 201–4.
- Ruelle, Charles-Emile, "Locus desperatus dans Aristoxène, Éléments harmoniques" *Revue de philologie* 30 (1906) 271–74.
- Ryffel, Heinrich, "Eukosmia (Ein Beitrag zur Wiederherstellung des Areopagitikos des Damon)" *Museum Helveticum* 4 (1947) 22–38.
- Ryffel, Heinrich, "Metabole politeion Der Wandel de Staatsverfassungen" *Noctes Romanae* 2 Bern (1949).
- Sachs, Curt, *The History of Musical Instruments* New York (1940).
- Sachs, Curt, *The Rise of Music in the Ancient World East and West* New York (1943).
- Sallmann, Nicolaus *Censorini de die natali liber ad Q. Caerellium* Leipzig (1983).
- Sandys, John Edwin, "ἁρμονία and τόνος in Greek Music" *Classical Review* 8 (1894) 397.
- Schaerer, René, Ἐπιστήμη et Τέχνη: Étude sur les notions de connaissance et d'art d'Homère à Platon Macon (1930).

- Schäfer, M., "Diogenes als Mittelstoiker" *Philologus* 91 (1936) 174–96.
- Schäfer, Rudolf, *Aristides Quintilianus Von der Musik* Berlin (1937).
- Scheithauer, Andrea, "Musik, musikalische Bildung und soziales Ansehen im frühen Griechentum" *Archiv für Musikwissenschaft* 53 (1996) 1–20.
- Schenkl, H., G. Downey and A. F. Norman, *Themistii Orationes Quae Supersunt* Vol. 2 Leipzig (1971).
- Schlesinger, Kathleen, "The Utrecht Psalter and its Bearing on the History of Musical Instruments" *The Musical Antiquary* II Oxford (1910–11) 18–33.
- Schlesinger, Kathleen, "Further Notes on Aristoxenus and Musical Intervals" *Classical Quarterly* 27 (1933) 88–96.
- Schlesinger, Kathleen, "The Harmonia" *Music Review* 5 (1944) 7–94.
- Scholz, H., "The Ancient Axiomatic Theory" in *Articles on Aristotle: 1. Science* (ed. Jonathan Barnes, Malcolm Schofield, Richard Sorabji) London (1975) 50–64; revised from "Die Axiomatic der Alten" in *Blätter für deutsche Philosophie* 4 (1930) 259–78.
- Schönberger, P. Leander O. S. B., *Studien zum I Buch der Harmonik des Claudius Ptolemäus* Ausburg (1914).
- Schrade, Leo, "Music in the Philosophy of Boethius" *Musical Quarterly* 33 (1947) 188–200.
- Schuhl, P. M., "Platon et la musique de son temps" *Revue internationale de philosophie* 32 (1955) 276–287.
- Scott, J. E., "Roman Music" in *Ancient and Oriental Music* (*The New Oxford History of Music* Vol. I) (ed. Egon Wellesz) Oxford (1957) 404–419.
- Shackleton Bailey, D. R., *Cicero: Letters to Atticus* 4 Vols. Cambridge Mass. (1999).
- Shellens, Max Salomon, "Die Bedeutung der 'Katharsis' in der Musiklehre des Aristotles" *Archiv für Philosophie* 7 (1957) 229–43.
- Shirlaw, Matthew, "The Music and Tone Systems of Ancient Greece" *Music Review* 4 (1943) 14–27.
- Shirlaw, Matthew, "Claudius Ptolemy as Musical Theorist" *Music Review* 16 (1955) 181–190.
- Shorey, Paul, "Notes on Sextus Empiricus Πρὸς μουσικούς 21" *Classical Philology* 11 (1916) 99.
- Shorey, Paul, *Plato: Republic* 2 Vols. Cambridge, Mass. (1930–1935).
- Smits, J. P. H. M., *Plutarch en de Griekse Musiek* Bilthoven (1970).
- Solomon, Jon, "Orestes 344–45: Colometry and Music" *Greek, Roman and Byzantine Studies* 18 (1977) 71–83.
- Solomon, Jon, "Cleonides: ΕΙΣΑΓΩΓΗ ἈΡΜΟΝΙΚΗ: Critical Edition, Translation and Commentary" Ph. D. dissertation, University of North Carolina-Chapel Hill (1980).
- Solomon, Jon, "Ekbole and Eklusis in the Musical Treatise of Bacchius" *Symbolae Osloenses* 55 (1980) 111–26.
- Solomon, Jon, "The Diastaltic Ethos" *Classical Philology* 76 (1981) 93–100.
- Solomon, Jon, "Towards a History of *Tonoí*" *Journal of Musicology* 3 (1984) 242–251.

- Solomon, Jon, "Vaticanus gr. 2338 and the ΕΙΣΑΓΩΓΗ 'ΑΡΜΟΝΙΚΗ" *Philologus* 127 (1984) 247–253.
- Solomon, Jon, *Harmony in Ptolemy's Harmonics* Gordon Athol Anderson Memorial Lecture 8. Uni of New England, N.S.W. (1990).
- Solomon, Jon, "A preliminary Analysis of the Organisation of Ptolemy's *Harmonics*" in *Music Theory and its Sources* (ed. A. Barbara) Notre Dame (1990) 68–84.
- Sommerstein, Alan H., *The Sound Pattern of Ancient Greek* Oxford (1973).
- Stahl, William Harris, Richard Johnson and E. L. Burge, *Martianus Capella and the Seven Liberal Arts* 2 Vols. New York (1971–1977).
- Stählin, Otto, *Clemens Alexandrinus: Stromata Buch I–VI* Leipzig (1906).
- Steinmayer, Otto, "Bacchius Geron's *Introduction to the Art of Music*" *Journal of Music Theory* 29 (1985) 271–298.
- Steinmetz, Peter, "Die Krise der Philosophie in der Zeit des Hochhellenismus" *Antike und Abendland* 15 (1969) 122–134.
- Stieglitz, Robert R., "Minoan Mathematics or Music?" *Bulletin of the American Society of Papyrologists* 15 (1978) 127–132.
- Strunk, Oliver, *Source Readings in Musical History* London (1952)
- Sullivan, Blair, "Nota and Notula: Boethian Semantics and the Written Representation of Musical Sound in Carolingian Treatises" *Musica Disciplina* 47 (1993) 71–97.
- Süss, Wilhelm, "Über den Chiron des Pherekrates" *Rheinisches Museum* 110 (1967) 26–31.
- Tanner, Robert, "La musique antique grecque" *Revue Musicale* 248 (1961) 5–72.
- Tannery, Paul, "Sur les intervalles de la musique grecque" *Revue des études grecques* 15 (1902) 336–352.
- Tannery, Paul, "Du rôle de la musique grecque dans le développement de la mathématique pure" *Bibliotheca Mathematica* 3 (1902) 161–175.
- Tannery, Paul, "À propos des fragments philolaïques sur la musique" *Revue de philologie* 28 (1904) 233–49.
- Tannery, Paul, "Sur le spondiasme dans l'ancienne musique grecque" *Revue archéologique* 4 (1911) 41–50.
- Thomson, William, "The Problem of Tonality in Pre-Baroque and Primitive Music" *Journal of Music Theory* 2 (1958) 36–46.
- Thorp, John "Aristoxenus and the Ethnoethical Modes" in *Harmonia Mundi: Musica e filosofia nell'antichità* (ed. R. Wallace and B. MacLachlan) Rome (1991) 54–68.
- Tiby, O., *La musica in Grecia e a Roma* Florence (1942).
- Troelsgard, Christian, "Ancient Musical Theory in Byzantium Environments" *Cahiers de l'institut du moyen age grec et latin* 56 (1988) 228–238.
- Turner, E. G., "Two unrecognised Ptolemaic Papyri" *Journal of Hellenic Studies* 76 (1956) 95–98.
- Turner, E. G., and W. P. Winnington-Ingram, "2436. Monody with Musical Notation" *Oxyrhynchus Papyri* 25 (1959) 113–122; Plate XIV.

- Turner, R. L., "A Note on the Word 'Accent in Greek Music" *Classical Review* 29 (1915) 195–6.
- van der Valk, M., *Eustathii Commentarii ad Homeri Iliadem Pertinentes* Vol. III Leiden (1979).
- van der Waerden, B. L., "Die Harmonielehre der Pythagoreer" *Hermes* 78 (1943) 163–99.
- Vecchia, Patrizia Dalla and Donatella Restani (eds.), *Trent'anni di Ricerca Musicologica: Studi in Onore di F. Alberto Gallo* Rome (1996).
- Vetter, Walther, "Die Musik im platonischen Staate" *Neue Jahrbücher* 11 (1935) 306–20.
- Vetter, Walther, "Musikalische Sinndeutung des antiken Nomos" *Zeitschrift für Musikwissenschaft* 17 (1935) 289–304.
- Vetter, Walther, "Die antike Musik in der Beleuchtung durch Aristoteles" *Archiv für Musikforschung* 1 (1936) 2–41.
- Vetter, Walther, "Griechenland: Antike Musik" *Die Musik in Geschichte und Gegenwart* 5 (1956) 839–65.
- Villari, Elisabetta, "Une Hypothèse sur des Sources d'Athénée (*Deipn.* I 20 e-f) et de la *Vita Sophoclis* (§§3–5): Aristoxène, Musicien et Biographe" *Revue des Etudes Grecques* 109 (1996) 696–706.
- Visconti, Amedeo, *Aristosseno di Taranto* Naples (1999).
- Visconti, Amedeo, "Musica e attività politica in Aristosseno di Taranto" *Tra Orfeo e Pitagora: Origini e incontri di Culture nell' Antichità* (ed. M. Ghidini, A. Marino and A. Visconti) Bibliopolis (1998) 463–485.
- Vogel, M., *Die Enharmonik der Griechen* 2 Vols. Düsseldorf (1963).
- Wallace, Robert W., "Damone di Oa ed i suoi Successori: Un'Analisi delle Fonti" in *Harmonia Mundi: Musica e filosofia nell'antichità* (ed. R. Wallace and B. MacLachlan) Rome (1991) 30–53.
- Wallace, Robert W., "Music Theorists in Fourth-Century Athens" in *Mousike: Metrica, ritmica e musica greca in memoria di Giovanni Comotti* (ed. B. Gentili and F. Perusino) Pisa (1995) 17–39.
- Wallace, Robert W., and MacLachlan, Bonnie (eds.), *Harmonia Mundi: Musica e filosofia nell'antichità Biblioteca di Quaderni urbinati di cultura classica* Vol. 5 Roma (1991).
- Wartelle, Andre, "Remarques sur la musique grecque et ses modes" *Bulletin de l'Association Guillaume Budé* (1993) 219–225.
- Wasserstein, A., "Theaetetus and the History of the Theory of Numbers" *Classical Quarterly* n.s. 8 (1958) 165–79.
- Wegener, Heinz (ed.), *Musa-Mens-Musiki. Im Gedenken an Walther Vetter*. Leipzig (1969).
- Wegner, Max, "Griechenland: B. Griechische Instrumente und Musikbrauche" *Die Musik in Geschichte und Gegenwart* Kassel and Basel 5 (1956) 865–881.
- Wehrli, Fritz, "Die antike Kunsttheorie und der Schöpferische" *Museum Helveticum* 14 (1957) 39–49.

- Wehrli, Fritz, *Aristoxenos (Die Schule des Aristoteles Vol. II)* 2nd Ed. Basle (1967).
- Weil, Henri and Reinach, Theodore *Plutarque: De la musique* Paris (1900).
- Werner, Eric, "Pseudo-Plutarch's Views on the Theory of Rhythm" *Orbis musicae* 7 (1979–80) 27–36.
- Wesoly, Marian, "'Lira dalle undici corde': per l'interpretazione del fr. 5 G-P di Ione di Chio" *Annali dell'Istituto Universitario Orientale di Napoli* XII (1990) 89–98.
- West, M. L., *Iambi et Elegi Graeci* Vol. 1 Oxford (1971a).
- West, M. L., "Stesichorus" *Classical Quarterly* 21 (1971b) 307–9.
- West, M. L., "The Singing of Homer and the Modes of Early Greek Music" *Journal of Hellenic Studies* 101 (1981) 113–129.
- West, M. L., "Music in Archaic Greece" *Actes du VIIe Congrès de la Fédération internationale des associations d'études classiques* (ed. Janos Harmatta) Budapest (1984) 213–20.
- West, M. L., "Bélis: Aristoxène de Tarente et Aristote: Le Traité d'harmonique" *Journal of Hellenic Studies* 108 (1988) 235–236.
- West, M. L., *Ancient Greek Music* Oxford (1992).
- West, M. L., "Analecta Musica" *Zeitschrift für Papyrologie und Epigraphik* 92 (1992a) 1–54.
- West, M. L., "The Babylonian Musical Notation and the Hurrian Melodic Texts" *Music and Letters* 75 (1993/4) 161–179.
- West, M. L., "When is a Harp a Panpipe? The meanings of $\pi\eta\kappa\tau\acute{\iota}\varsigma$ " *Classical Quarterly* 47 (1997) 48–55.
- West, M. L., "Texts with Musical Notation 4461–4467" *Papyrus Oxyrhynchus* 65 (1998) 81–102.
- Westphal, Rudolf, *Die Musik des Griechischen Alterthums* Leipzig (1883).
- White, John D., *Theories of Musical Texture in Western History (Perspectives in Music Criticism and Theory Vol. I)* New York (1995).
- Whittaker, Molly, *Tatian: Oration ad Graecos and Fragments* Oxford (1982).
- Wilamowitz-Mocellendorff, Ulrich von, *Griechische Verskunst* Leipzig (1921).
- Wilkinson, L. P., "Philodemus on *Ethos* in Music" *Classical Quarterly* 32 (1938) 174–181.
- Wille, Günther, *Schriften zur Geschichte der antiken Musik: mit einer Bibliographie zur antiken Musik 1957–1987* Frankfurt (1997).
- Wille, Günther, *Musica romana: Bedeutung der Musik im Leben der Römer* Amsterdam (1967).
- Williams, C. Abdy, *The Aristoxenian Theory of Musical Rhythm* Cambridge (1911).
- Williams, C. Abdy, "The Notes Mese and Hypate in Greek Music" *Classical Review* 12 (1898) 98–100.
- Williams, C. Abdy, "The Aristoxenian Theory of the Rhythmical Foot" *The Musical Antiquity* 2 Oxford (1910–11) 200–7.
- Willis, James A., *Martianus Capella* Leipzig (1983).
- Wilson, N. G., *Photius: The Bibliotheca* London (1984).
- Winnington-Ingram, R. P., "The Spondeion Scale" *Classical Quarterly* 22 (1928) 83–91.

- Winnington-Ingram, R. P., "Ancient Greek Music: A Survey" *Music and Letters* 10 (1929) 326–45.
- Winnington-Ingram, R. P., "Aristoxenus and the Intervals of Greek Music" *Classical Quarterly* 26 (1932) 195–208.
- Winnington-Ingram, R. P., *Mode in Ancient Greek Music* Cambridge (1936).
- Winnington-Ingram, R. P., "The Pentatonic Tuning of the Greek Lyre: A Theory Examined" *Classical Quarterly* 6 (1956) 169–86.
- Winnington-Ingram, R. P., "Ancient Greek Music 1932–1957" *Lustrum* 3 (1958) 5–57.
- Winnington-Ingram, R. P., *Aristidis Quintiliani De Musica libri tres* Leipzig (1963).
- Winnington-Ingram, R. P., "The First Notational Diagram of Aristides Quintilianus" *Philologus* 117 (1973) 243–49.
- Winnington-Ingram, R. P., "Two Studies in Greek Musical Notation" *Philologus* 112 (1978) 237–248.
- Winnington-Ingram, R. P., "Greek, Ancient" *New Grove's Dictionary of Music and Musicians* London (1980) 7:659–72.
- Winnington-Ingram, R. P., "Kónnos, konnàs, cheride e la professione di musicò" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 246–63.
- Winterbottom, M., *M. Fabi Quintiliani Institutio Oratoria* Oxford (1970).
- Winternitz, Emanuel, "Further Evidence of Open Strings in Classical Greek Music, 5th and 4th Centuries BC" *RldIM RCMi Repertoire International d'Iconographie Musicale/Research Centre for Musical Iconography Newsletter* 2/1 (1976) 5–6.
- Wolf, Ernst, "Zur Etymologie von $\rho\upsilon\theta\mu\acute{o}\varsigma$ und seiner Bedeutung in der älteren griechischen Literatur" *Wiener Studien* 68 (1955) 99–119.
- Zaminer, Frieder, "Pythagoras und die Anfänge des musiktheoretischen Denkens bei den Griechen" *Jahrbuch des Staatlichen Instituts für Musikforschung* (1979–80) 203–11.
- Zaminer, Frieder, "Konsonanzordnung und Saitenteilung bei Hippasos von Metapont" *Jahrbuch des Staatlichen Instituts für Musikforschung* (1981–2) 231–40.
- Zaminer, Frieder, "Hypate, Mese und Nete in frühgriechischen Denken" *Archiv für Musikwissenschaft* 41 (1984) 1–26.
- Zaminer, Frieder, "Il contrapposto ritmico negli anapesti di marcia del dramma greco" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 181–188.
- Zaminer, Frieder and Michael Bernhard (eds.), *Rezeptionen des antiken Fachs im Mittelalter (Geschichte der Musiktheorie Vol. III)* Darmstadt (1990).
- Zanoncelli, Luisa, "La philosophia musicale di Aristide Quintiliano" *Quaderni Urbinati di Cultura Classica* 24 (1977) 77–81.
- Zanoncelli, Luisa, *La manualistica musica greca* Milan (1990).
- Zanoncelli, Luisa, "Boezio Matesiomusico" in *Trent'anni di Ricerca Musicologica: Studi in Onore di F. Alberto Gallo* (eds. P. Dalla Vecchia and D. Restani) Rome (1996) 241–249.
- Ziegler, Konrat, and M. Pohlenz, *Plutarchi: Moralia* Vol. 4, Leipzig (1953).
- Zimmermann, Bernhard, "Critica ed imitazione: La nuova musica nelle commedie di Aristofane" in *La musica in Grecia* (ed. B. Gentili and R. Pretagostini) Rome (1988) 199–204.

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